The PRACTICAL MAGAZINE:

AN ILLUSTRATED CYCLOPÆDIA OF

INDUSTRIAL NEWS, INVENTIONS AND IMPROVEMENTS,

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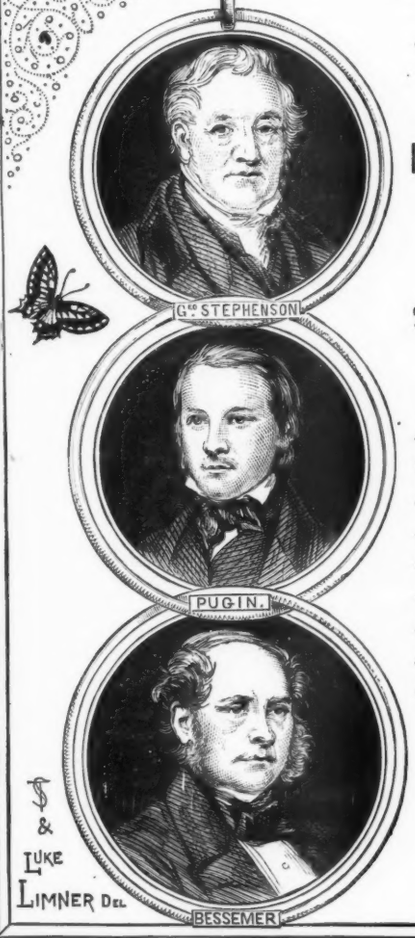

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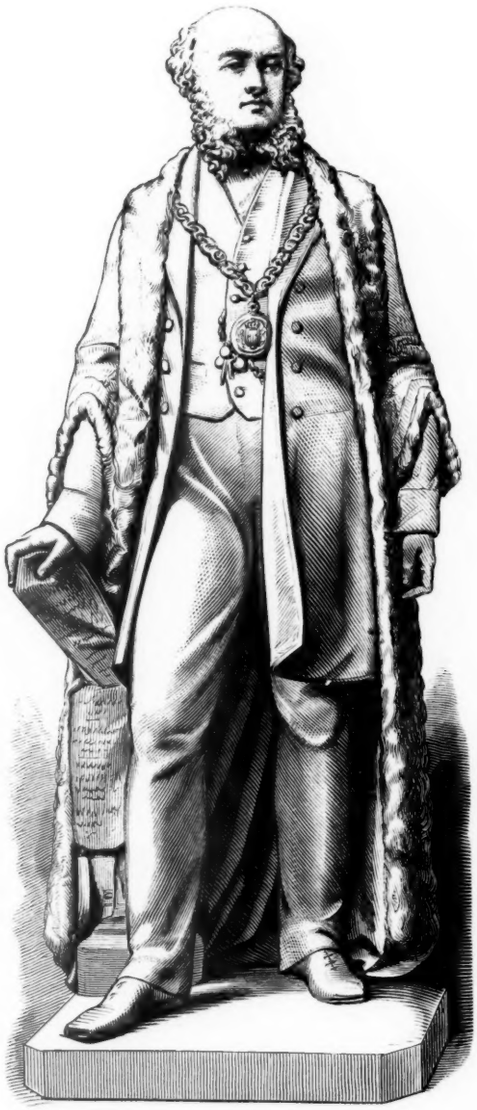


(After the statue by Noble.)

SIR JAMES RAMSDEN AND THE GROWTH OF BARROW-IN-FURNESS.

THE old proverb," says an American wit, "of having too many irons in the fire, is an abominable old lie—shove all in, poker, tongs, and shovel!"—a revision of the ancient saw, that illustrates admirably the peculiar and many-sided business talents of our adventurous brethren. But even at home the days of cautious plodding in one, and only one, trade-groove are over. The men whose efforts are now crowned with a princely success are invariably endued with minds quick to seize every possible opportunity, and comprehensive enough to weld enterprises and speculations the most divergent into one skilfully organized and easily-directed whole. We could scarcely have a better example of this form of modern business achievements than is afforded by the career of the subject of our memoir, in connection with the rapid growth and extraordinary prosperity of the town of Barrow-in-Furness—indeed, they are inseparable,

and must be considered together. The problem simply stated is this: Given a little fishing-village in Morecambe Bay, with a wooden jetty, and some dozen huts and houses, to show how, by a series of rapid and brilliant transformations, it can be turned into a city so thriving in its multifarious trades, so full of pluck and energy, so marvellously expansive, that, to find a parallel, we must visit the seaboard of California and the western plains of America. On paper the solution is not difficult; and the successive steps have a natural and apparently easy sequence. Start a railway in a district yet unopened, but which gives promise of mineral wealth, and let the railway company become themselves the owners of large tracts of lands. Little by little, as they develop their traffic, let them explore their possessions, and have spirit enough to knock away the wooden jetty and the fishermen's huts, supplying their places with a stone pier and a railway dépôt, and a little workmen's village; then laying the village out as a town, encourage the best and most venturesome spirits in the neighbourhood to take part in their enterprises; and as the iron trade increases in the country, let them become gigantic iron-masters, working their own mines, owning their own coal-pits, smelting their own ore, and converting their own raw material into manufactured iron and steel—nay, even into steam-vessels. As the mineral trade increases, the stone pier is condemned; first one large dock is constructed, then another and another. Lines of vessels from rival towns are tempted thither, lines of steamers of their own are started; till, with the docks on one hand, and the steel works on the other, they see how advantageously they might build their own steamships, and large ship-building works are opened. Work is wanted for the wives and children of their *employés*, and a jute-mill is forthwith erected. And so, by degrees, the whole town has sprung up, till it is important enough to demand corporate rights; and in choosing their first mayor, the inhabitants tell all outsiders openly who it was behind the railway company, and the many enterprizes emanating from it, had directed affairs so skilfully and with such a signal success; and the secret and key-note of our problem stands revealed in the person of James Ramsden.

James Ramsden, son of the late William Ramsden, of Liverpool, was born in the year 1822, and received such an education as to thoroughly fit him for practical pursuits; and in the year 1845 he entered the service of the newly formed Furness Railway Company in the engineering department.

Up to this date the district of Furness, though rich in iron ore, had been without the advantages of a railroad, and though there had been an increase in the iron ore trade, Barrow was still a quiet little sea-side village, with eight or ten low-roofed cottages, a couple of public-houses, and one or two farmsteads. Through the influence of the Duke of Devonshire (then the Earl of Burlington) and the Duke of Buccleugh the railway company was formed and the bill carried through Parliament. The original line extended only from Kirkby Ireleth and a point near Lindal, to Barrow, only fifteen miles, but in the following year powers were obtained for extension to Ulveston on the south, and Broughton on the north; subsequently the connection with Whitehaven was effected.

Soon after the opening of the Furness Railway, the head-quarters of the company were established at Barrow, and this at once gave a great impetus to the quiet little village. James Ramsden, who had entered only as a junior, displayed such organizing powers and administrative capacities, that he was shortly promoted to the post of general manager, and in 1850, when Mr. Arthur Currey retired from the secretaryship, that post also was bestowed upon the general manager, who now, in his own person, combined these two important positions.

The duties depending on these offices, though probably requiring skill as well as zeal in their due performance do not afford much scope to the biographer's pen. The iron trade in the district was rapidly developing, but as yet the gentlemen who had formed and started the railway company were only reaping an indirect benefit from it.

In the year 1857 there were altogether two-and-twenty hematite iron ore mines in the district, and though their united annual produce amounted to upwards of 464,853 tons, nearly the whole of this was shipped to Wales, Staffordshire, and the West Riding of Yorkshire, and the local consumption for smelting purposes was almost insignificant.

We must pause for a moment to consider the geological formation of the country.

The hematite ore in the district of Lower Furness is found in the strata of carboniferous or mountain limestone, being, as far as ascertained, about seven miles long by a greatest breadth of four miles; the general dip is towards the south-east. These deposits, which last year produced more than 2,000,000 tons of ore, may be divided into two classes:—1. Deposits filling out irregular hollows. 2. Deposits of vein-like appearance, filling out fissures of various width.

Both sorts are sometimes combined; but the following table exhibits these two classes of deposits as worked by the various mines in the district:[1]—

Deposits in Hollows.	Deposits in Fissures.
Askam	Bolton Heads
Carr Kettle	Gilbrow (Lindale Moor)
Cross Gates	Lindale Cote
Dalton Mine (Denny's)	Longlands
ditto (Clegg's)	Lindale Moor
Eure Pits (Ulveston M. Co.)	Newton
Ellis-cales	Oldhills
Green Haume	Pennington
Lindale Moor (California)	Plumpton
Monsell	Stainton
Park	Stank
Parkhouse	Tarn Close
Poaka	Thwaite Flat
Roanhead	Urswick
Stonefolds	Whitriggs

The hematite that fills these deposits resembles a huge chemical precipitate, consisting for the most part of minute particles, in which larger pieces are embedded. It seems, according to the chief authorities, especially Professor Sedgwick, to be of a chemical aqueous formation; others, however, maintain that it was injected into the places where it is now found by direct volcanic or igneous agency.

The enterprise that, after the railway company, had the most influence upon the early progress of Barrow, was the erection of blast-furnaces by Messrs. Schneider and Hannay, who had for a considerable period previously been engaged in extensive mining operations in the district. Started in 1857, these furnaces commenced work in 1859. Their well-selected situation, close at once to the shore and the mines, and the excellent construction and arrangement of the furnaces, were most important elements of success. But what was even more essential was the adoption of Mr. Bessemer's great invention as soon as ever it had obtained a practical value. This new process greatly increased the saleable value of their pig-iron, and they added one blast-furnace after another. In 1860 they possessed four; in 1862, seven; and in 1866, ten in full operation.

In 1864, Mr. James Ramsden, still manager and secretary of the Furness Railway Company, projected and formed the Barrow Steel Company, which erected large works opposite the furnaces at Hindpool, Barrow, for the purpose of converting the produce of those furnaces into Bessemer steel, and then manufacturing the valuable material into rails, axles, tires, and the other hundred forms in which Bessemer steel is now used. It very soon after became apparent that the two operations of smelting the ore and converting it into steel were so nearly allied in interest as well as in locality that an amalgamation was proposed between these works and those owned by Messrs. Schneider and Hannay, and was effected in 1866 under the title of "The Barrow Hematite Steel Company (Limited)." The Duke of Devonshire became chairman, and Mr. Ramsden managing director, and it was virtually only an offshoot of the original enterprise of the railway company. They now possess twelve blast-furnaces complete, and in connection with these one of the largest Bessemer steel works in the world. These twelve furnaces stand close to the sea-shore, being arranged in one straight line, but forming two groups of different sizes. The slag is tilted direct into the sea, and has already given a large increase of land on the sea-side, upon which whole series of stores, workshops, and other accessory buildings have been erected. For the present weekly production of about 5,000 tons of iron, the quantities of 10,000 tons of ore and limestone and about 5,000 tons of coke are needed. What would poor Dud Dudley, who first introduced the use of coal for smelting purposes into England, have said to this, when scarcely more than 200 years ago, he writes complainingly: "Some of the now going Furnaces with Charcole do make two or three Tun of Pigg or cast iron in 24 hours . . . which quantity of cast iron, with pit cole & Sea-cole at one Furnace I desire not but am contented with half the proportion!"

The Barrow Steel Works are, however, the largest Bessemer steel works in the country; and in addition to the foregoing, the company own the productive mines of Parks, Whitriggs, Newton, Stank, &c. It is believed that their profit last year was not much under three-quarters of a million sterling.

This year 1866, in which Mr. Ramsden became the managing director of the steel works, was in more ways than one an epoch of his life. Owing to the retirement from the board of directors of the railway company of two of its members it became neces-

[1] For further information see Würzburger in the "Journal of the Iron and Steel Institute," 1872; and Mr. E. W. Binney's "Reports."

sary that the governing body should be reconstructed, and the directors felt that the interests of the company would be best promoted and its affairs most conveniently and satisfactorily managed by the appointment of Mr. Ramsden, the general manager, as a director. The high opinion entertained of his abilities, and the great confidence reposed in him by the directorate, may be inferred from this signal honour, and from the following tribute to his worth, extracted from their half-yearly report to the shareholders:—

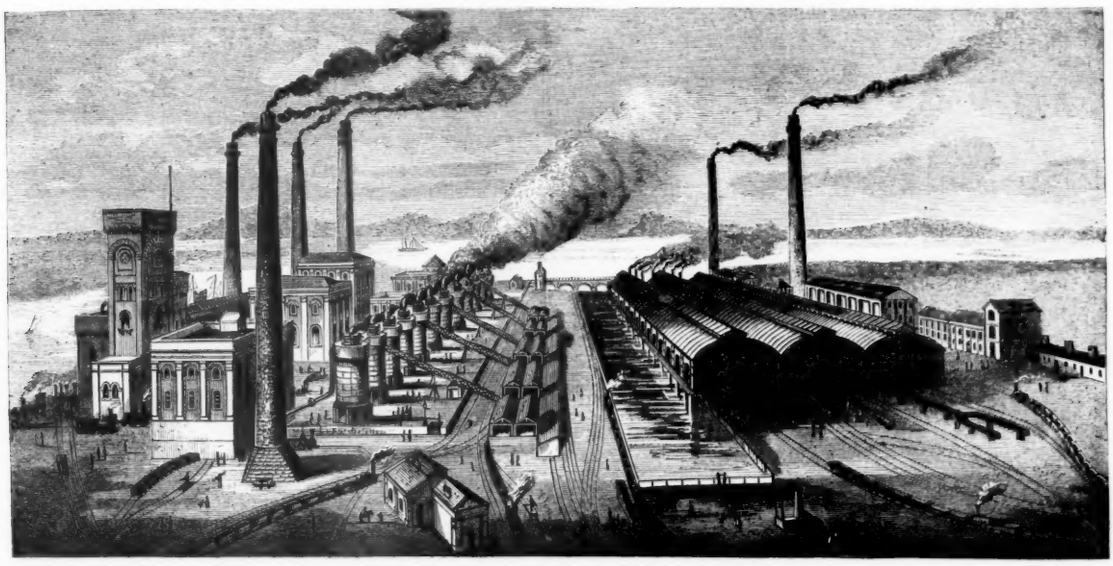
"Mr. Ramsden's connection with the company has now existed for nearly twenty years, and during the whole of that period not only have the directors had every reason to be satisfied with him as their general manager, but they feel that his ability and energy have been largely instrumental in promoting the prosperity which the company has so long enjoyed."

The opinion of the directors was unanimously ratified by the general body of the shareholders, and Mr. Ramsden took his seat at the board as a director of the company, the management of whose affairs he had so long conducted in the most satisfactory manner. Mr. Henry Cook, the late secretary of the Whitehaven and Furness Railway, was at the same time appointed to the situation of secretary and traffic manager of the Furness Railway Company.

At the time Mr. Ramsden was first mooting the idea of the steel works his active mind was engaged also on an undertaking of but little less magnitude and utility—viz., the formation of such docks as should make Barrow altogether unrivalled as a seaport-town on the large seaboard between Liverpool and the Clyde. The construction of two large docks was commenced in 1864. They were formed simply by enclosing the channel separating the town from Barrow Island by an extensive quay, forming the dock wall on the mainland side. The cost of actual formation was, owing to the natural facilities of the site, only £200,000, and the gross total was within £300,000. The contract was undertaken by Messrs. Brassey and Co., and Messrs. M'Clean and Sliteman.

All these enterprises had given an immense impetus to the growth of the town. In 1847 the population had only been 325, but in 1866 the number had increased to 16,000. As a necessary result, the question of the future government of an important and rapidly increasing community was forced upon its leading men. A petition was forwarded to the Privy Council, praying that Barrow might be created into a corporate town, and begging that the nomination of the first town-council should be placed in the hands of the Duke of Devonshire.

The Government promptly granted a royal commission upon



BARROW HEMATITE STEEL WORKS.

the subject; but nothing further transpired until the 13th June, 1867, when the charter was received, the title of the corporate body being fixed as "The Mayor, Aldermen, and Burgesses of Barrow." The charter declaring that the council should consist of a mayor, four aldermen, and twelve councillors, Mr. James Ramsden was naturally nominated by the Duke of Devonshire among the four aldermen; and at the first council-meeting, held at the town-hall on the 15th of July, 1867, he was unanimously elected the first mayor. At a subsequent meeting the Local Government Act, 1858, was adopted in the borough.

The completion in this year, 1857, by the Ulveston and Lancaster Railway Company, of their line from Ulveston to Carnforth, gave Barrow an uninterrupted chain of railway communication between all parts of the kingdom, and was followed by immensely increased shipments of ore, with a corresponding increase in the trade of the district generally and in the population of the town in particular.

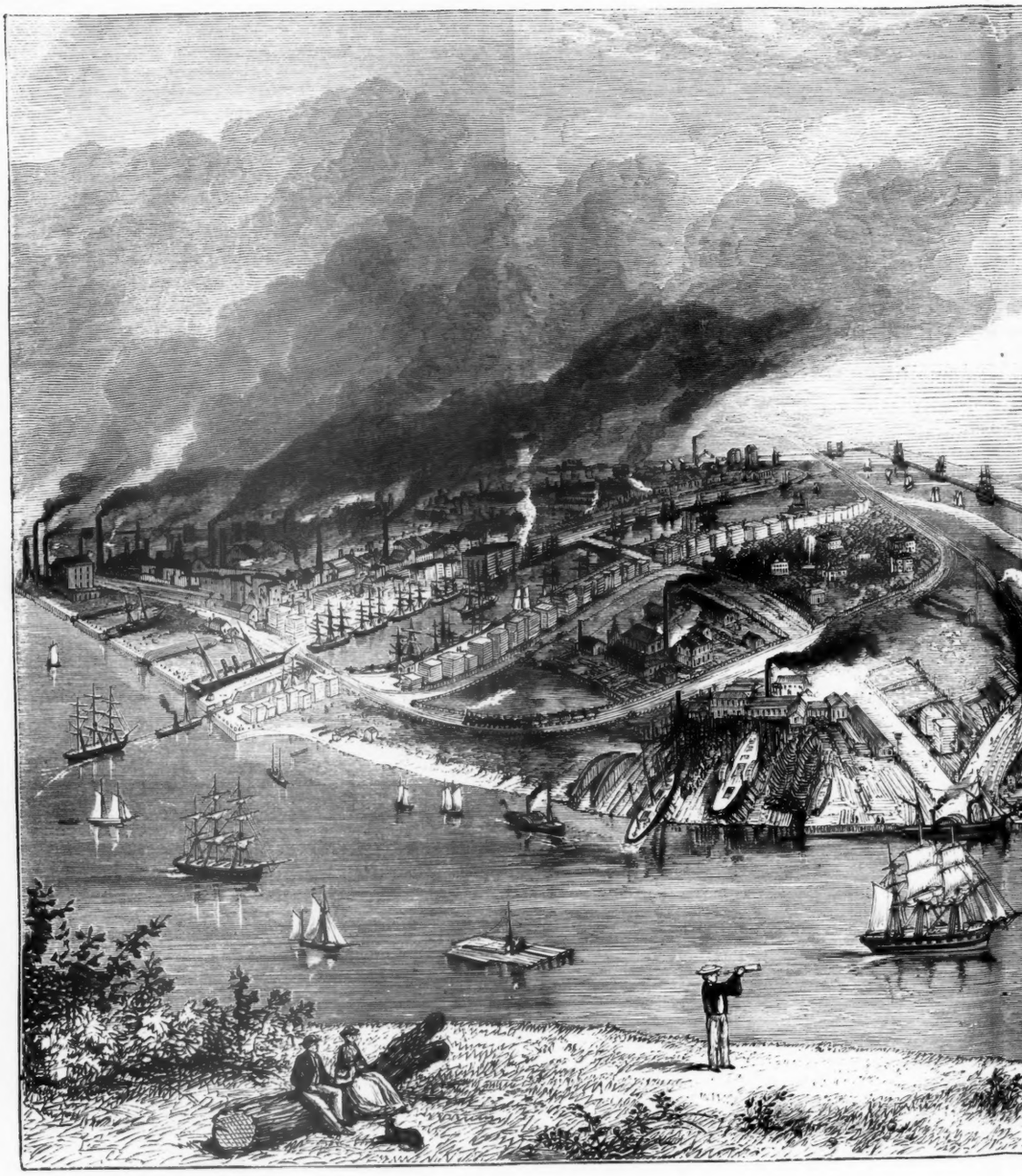
In the meantime the docks had approached completion, and it was determined to celebrate the prosperity of the town by a formal inauguration of the Devonshire Dock, on the 24th of September, 1867. High festival was held that day, and an immense concourse of visitors was invited or attracted.

The proceedings were opened by the presentation, from the tradesmen of the locality, of a congratulatory address to Mr. Ramsden, thanking him for the zeal and ability which he had ever displayed in the interests of Barrow-in-Furness, and declaring that it had been the united wish of all the inhabitants that he should be the first to occupy the civic chair.

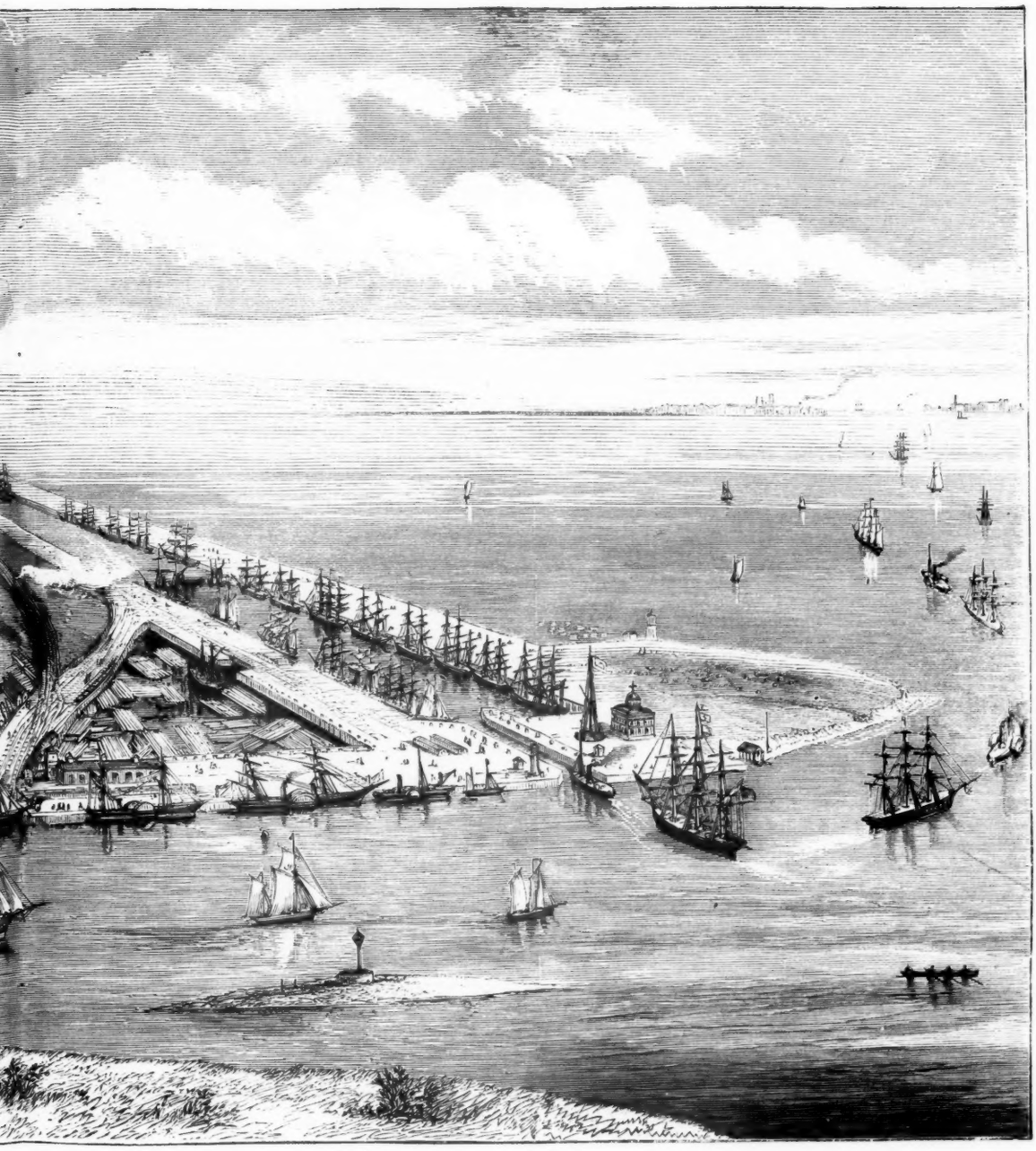
The procession was then formed, the docks opened, and the various works inspected. The rejoicings concluded with a banquet, at which many of the leading men in the country were present. The chairman (the Duke of Devonshire, the Duke of Buccleugh occuping the vice-chair), in proposing success to Barrow Docks, contrasted the present with the past:—

"The enterprise of the iron ore merchants, combined with the unceasing exertion and far-seeing policy of Mr. Ramsden, who was in the service of the (railway) company from the first, soon brought about a great and auspicious change. Within three years the quantity of ore exported from Barrow increased (from say 60,000 tons) to 150,000 tons, within five years to 250,000, and in less than ten years after the opening of the railway it rose to 450,000 tons. . . . In reference to the docks, the utility and necessity of the undertaking had long been felt; and the company's engineers found out that the nature of the situation afforded peculiar facilities for their construction—in fact, that nature had already done half the work. The result is now before us. The docks have been constructed so cheaply that only very light dues need be charged. The railway runs down to them, so that there will be the utmost facilities for shipping produce to all parts of the kingdom; and a third advantage is that the approach to the docks is by Piel Harbour, which is one of the best harbours in the kingdom."

Mr. Gladstone, while acknowledging the present, ventured on the other hand, to look into the future, and with the certainty as to eventualities and the prophetic vision that has ever distin-



BIRD'S-EYE VIEW OF

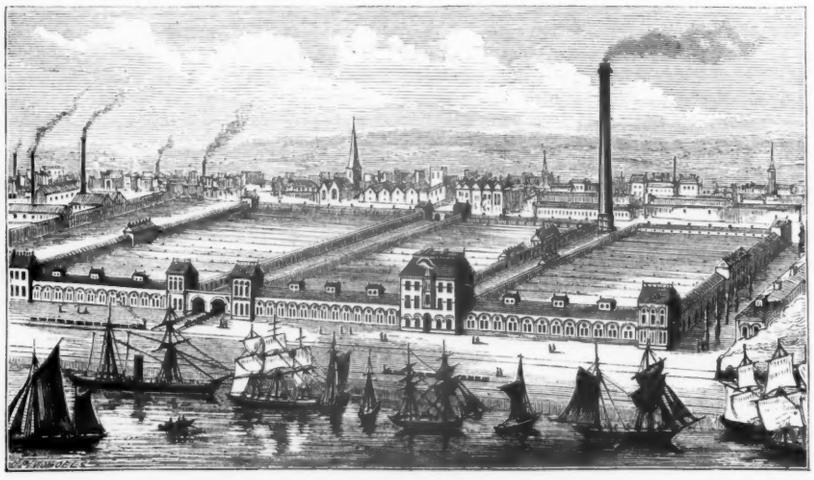


OF BARROW-IN-FURNESS.

guished his as one of our leading business minds, and assuredly as our greatest speaker upon business matters, said :—

"With regard to Barrow itself, I really do not know how to speak of such a place in terms which would be adequate to the subject, and at the same time would not appear to bear the character of exaggeration; but I must say that for combination of natural advantages afloat and natural advantages ashore, it probably would not be practicable to find a match for it in any portion of the country. (Applause.) And saying that, gentlemen, is saying much, because we have had in other portions of this country, especially within our own generation, instances of progress so extraordinary as to outstrip all past European examples, and almost to seem to defy the future. . . . I am sure the whole circle of productive industry and trade cannot produce to you a similar picture (cheers), and how extraordinary it is that in what we call an old country like this there is still so much youth (cheers)—that there is still an energy which develops and expands itself with a rapidity so extraordinary that if we can suppose former times to have been capable of such a movement, the present state of England as to industry and trade would have been I know not how many hundredfold what it is. There are, no doubt, great responsibilities connected with this progress. Driving through the town of Barrow in the short interval afforded to-day, it was impossible to look without great satisfaction upon the appearances of comfort, and upon the good and sound arrangements apparently made for the health and advantage of the population, showing that amid the pursuit of wealth those high and sacred purposes have not been and—again I venture to prophesy—under such auspices will not be forgotten. (Cheers.) I do not transgress the bounds of prudence when I say that the progressive impetus of iron, the continued pressure of iron upon the prices of other useful materials, is a progress so rooted and fixed in the essential wants of society, and so developed in ten thousand forms, that it assumes the character of a law of modern trade and industry; that the basis upon which the prosperity of this town is to be built is not only a broad and solid basis, but one that we have the best and most solid reasons for believing we shall see extended from year to year of our lives."

The Devonshire Dock is thirty acres in extent, the Buccleugh Dock thirty-three, and outside of this latter there is a splendid timber pond. The entrances are sixty feet in width, the depth of water maintained twenty-two feet; they would consequently admit as large a vessel as H.M.S. the well-known iron-plated frigate the "Warrior." The stone quays are one and a-half miles in extent; the wharves adjoining one hundred acres, while there are at least ten miles of railway sidings. Cranes and capstans worked by hydraulic power were supplied by Sir William Armstrong, and the original warehouses, having a floor area of 17,000 square yards, have more recently been augmented by the erection of a gigantic warehouse by the side of the Devonshire Dock, divided into two blocks, each block five stories in height, and each possessing a floor area of 5,000 square



BARROW FLAX AND JUTE MILLS.

yards, the two being separated by a glass-covered transit shed.

The first influence of the dock upon the fortune and future prospects of the town was soon visible, for through the influence of Mr. Ramsden with the Midland Railway Company, now brought by the junction at Carnforth into immediate connection with the whole Furness district, the Barrow Steam Navigation Company, owned by the Midland Railway Company in partnership with Messrs. James Little and Co., was started at once, and in the August of 1868 the line of steamers which had for many years been trading under the same direction between Morecambe and Belfast was bodily transferred to the new port. The company's vessels also trade between Glasgow and Barrow, and at a later period Mr. Ramsden induced them to open a summer line to that popular resort, the Isle of Man. They intend shortly to establish in addition a complete service of steamers from Barrow to Dublin, Liverpool, Rotterdam, and the Mediterranean.

In other directions private enterprise has not been slow in utilizing the advantages of the new docks. Messrs. James Fisher and Sons hold the agency for the Pioneer line of ocean steamships from Barrow to Montreal. Messrs. Duncan and Co. have established steam communication between Barrow and Rotterdam, and Messrs Price, Potter, Walker and Co. import foreign timber at the rate of one hundred cargoes annually.

What with the iron industries and the shipping trade, the town was now rapidly increasing in something more than any given geometrical proportion could have forecast, and Mr. Ramsden, though busily engaged in managing or actively directing so many important enterprises, now thought that some employment should be afforded to the numbers of women and children who congregated idly and uselessly in a town where up to this date employment had only been provided for the male members of the community.

With a view, then, of remedying this condition of the labour market, of opening out another branch of industry, and also of affording an incentive to married men with families, whether employed at Barrow itself or at the mines in the vicinity, to make the town their home, and thus secure the advantages of a large residential labouring population, Mr. Ramsden towards the close of 1869 matured plans for the "Barrow Flax and Jute Company," having for its object the erection of works at Barrow for the purpose of spinning and weaving flax and jute, and the manufacture of coarse cloths, sacking, bagging, wrapperings, &c. The scheme was soon successful, and at present the mills, employing some fifteen hundred hands, form one of the most conspicuous architectural ornaments of the town. Business reacts upon business, one trade upon another, and the establishment of this manufactory has now a very beneficial effect upon the commercial interests of the port. The company have for some time regularly imported their own jute direct from India, and are about to establish a regular service from Calcutta. Dundee must look to it, or it will needs have to take ashes with its sackcloth.

This year, 1870, in which the jute mills were regularly opened for business, also saw the establishment of another large industry scarcely inferior to the steel works in outlay or ambition. This was the Barrow-in-Furness Iron Shipbuilding Company, and in

this, as in all the other enterprises, Mr. Ramsden was the leading and directing spirit. The company secured a large tract of land on Old Barrow Island, admirably adapted for launching purposes, while on the Devonshire Dock side the site was immediately connected with the railway system. There is here accommodation for the construction of from twelve to fifteen vessels at one time. A graving-dock is now in process of completion, which will afford the company the means of making repairs in a more substantial manner than was hitherto possible. These works already employ more than two thousand hands, and will when in full movement demand at least six or seven thousand men. The company have already contracted with the Barrow-in-Furness Ocean Steamship Company for six first-class steamers, each of which will be about 400 feet in length, of 4,000 tons burthen, and 500 horse-power. They are also building five steamships for the "Ducal" line of steamers trading to India, Ceylon, and the East generally, the inauguration of which line has taken place so recently and so successfully. These vessels, building here and at Glasgow, will be about 380 feet long, 38 feet beam, and 26 feet depth of hold, 500 horse-power, and 4,000 tons burthen.

It was found, however, that a link was required in converting the local iron-ore into fit material for shipbuilding purposes, and Mr. Ramsden consequently suggested the establishment of rolling mills, of which, as always, he was a promoter and a director. In the same year, too, he found that a growing population requires not only work and wages, but when they have earned wherewith to buy it, "the staff of life." As there was no similar establishment nearer than Whitehaven on the north and Lancaster on the south, it was determined to start a steam corn mill. The project met with very hearty support; he was chosen the chairman of the company; the undertaking thrived in itself; and more than that, it has served to greatly stimulate the import of grain into the district.

For all these works, as well as for the general prosperity of the town, Barrow is very largely indebted to the energy, ability, and business genius of Mr. J. T. Smith. From the kindliness of his disposition, from his genial manner, from the way in which he has invariably laid himself out to study the individual interests of all connected with the progress of the community, he has assuredly earned a right to the affectionate respect of all who have ever been brought into intimate connections with him, and has at one and the same time proved himself to be a skilful organizer, a kind master, a good friend, and a thorough man of business. He has naturally succeeded Mr. Ramsden as mayor of the borough.

Year by year Mr. Ramsden had received an acknowledgment of his labours, for he was, as surely as the date of election came round, re-nominated to the civic chair. On the occasion this year of his fifth re-election he gave an account of the importance and extent of enterprises newly initiated.

"Some idea," he said, "might be formed of the probable completion of the various works which are now in progress, when I mention that the total expenditure upon them will amount to something like half a million of money. I need hardly say that this expenditure must of itself have a directly beneficial influence upon trade in the district, while it is difficult to estimate the advantages which are likely to accrue in the future from works of this magnitude in full operation."

Being now in full command of the hematite ore, of smelting furnaces, of steel works, of rolling mills, and of shipbuilding-yards, Mr. Ramsden determined that the town and the gentlemen with whom he was associated might as well reap the full advantage of an extended commerce and of a likely investment by subscribing for shares of the "Barrow-in-Furness Ocean Steamship Company," with a capital of one million pounds sterling. Many of the leading capitalists in the country were anxious to join, and the shares were soon all taken up. As a natural consequence, the building of these vessels was, as we have before stated, entrusted to the Barrow Shipbuilding Company.

With all these maritime ventures, the existing dock accommodation was soon found too scanty, and two hundred acres were added on behalf of the railway company. The new enterprise was appropriately called the Ramsden Dock. Built for the before-mentioned ocean-going steamers, it will have, when completed, sufficient depth of water and width of entrance to accommodate vessels of the heaviest draught at all tides.

We have as yet scarcely mentioned the extensive works of the railway company, with which, from the first, Mr. Ramsden had been even more intimately connected than with any of the others. These works have a frontage of 180 feet on the one side and 260 feet on the other, and include blacksmiths' and joiners' shops, fitting shops, a locomotive shed capable of holding eighty engines, store-rooms, offices, &c. Upwards of 900 men are employed, and for their use an extensive library, a reading-room, and a billiard-room, are attached to the establishment.

Before we leave the railway for good we must say a word anent Messrs. Claye and Co.'s large rolling-stock works. This is a branch of their extensive establishment at Long Eaton, near Derby; but the offspring has rapidly outgrown the parent, and in a short time these new works for the construction of waggons and carriages will be unrivalled in England.

The chief characteristic of Mr. Ramsden, as outwardly exhibited in the town of his creation, is his extreme good taste in artistic and architectural matters. The docks, the streets, the public buildings, the railway stations, have all, even to their slightest detail, been determined by his judgment. Consequently we have a town, new still and unfinished, but with streets and squares of "London mould"—broad, lofty, and well built, and each one obviously only a portion of a vast and carefully-matured plan. Laid out on paper for 40,000 inhabitants, it already numbers 30,000 souls; and still the increase of population is so much greater than its building powers, that on Old Barrow Island, and elsewhere, little suburban villages of wooden huts have been erected to temporarily accommodate the gathering masses of labourers.

A stroll through the works and streets of Barrow gives one as true a picture as may be of a teeming hive of modern industry. "Not 'arms and the man,' but tools and the man, is the true epic of modern times!" says Mr. Carlyle; and here we have the very nursery of tooldom. Tall chimneys all around us, with their clouds of black, dense smoke; huge furnaces pouring out by day and night their wealth of fiery molten iron; the heavy thud of the steam-hammer; the sharp, ringing clangor of conflicting metals; the perpetual puffing and whistling of the locomotives; and the rattling of the railway-waggons laden with hematite and coal. These, and more than these, tell us something of the power and the achievements of the Age of Iron.

We have necessarily described only those works more intimately connected with Mr. Ramsden's career; but there are several enterprises of great importance, due solely to private energy, such as Messrs. Westray and Foster's engineering works, and Mr. Gradwell's works, employing some 1,300 persons, and turning out every requisite for a gigantic contracting business.

Among the public buildings we may note the North Lonsdale Hospital, of which Mr. Ramsden is president; the public baths, which he erected solely out of his private purse, and presented to the town; and the working men's club and institute, of which he was also the promoter. The "Barrow Daily Times" (now owned by the "Barrow Printing and Publishing Company") possesses offices that might well be the envy of many Fleet Street journals; while the Barrow Yacht Club in its new premises bids fair to attain the luxurious comforts and conveniences, if not the palatial proportions, of its metropolitan precursors.

Ample accommodation is provided for the play that shall prevent the thrifty inhabitants from becoming "dull boys," in the shape of the Theatre Royal, the Alhambra Palace, and the Alexandra Music Hall. There are two companies of volunteers, and also a volunteer fire brigade; while the cricket club, under the leadership of that distinguished player, Mr. Robinson Westray, has vindicated its right to the championship of the whole North-West country.

Returning again to Mr. Ramsden, we find that in November, 1870, the inhabitants of the town, desirous of showing their sense of his good services on behalf of Barrow, determined to provide a testimonial that should at once bear witness to this recognition and prove acceptable in his own eyes. Public feeling very soon declared itself in favour of the scheme, and a meeting was held, under the presidency of Mr. Schneider, for the purpose "of considering the best mode of acknowledging the services so ably rendered by the mayor in advancing the interests of the town." It was here resolved that the fifth year of the mayoralty of Mr. Ramsden should be signalized by a suitable testimonial in recognition of the skill and energy he had constantly displayed in fostering and regulating the growth of the town, and of his unwearied efforts to promote its prosperity, and that the testimonial should take the form of a statue, to be placed in the centre of Ramsden Square, at the junction of Abbey Road and Duke Street. It was also resolved that Mr. Noble, one of the most eminent sculptors of the day, should be entrusted with the work. The Ramsden statue fund was opened immediately after this meeting, but the subscriptions were not to exceed £100 each. In a remarkably short space of time upwards of £3,000 was subscribed. The statue in bronze cost £1,500, and the pedestal, which is of granite, £500.

The unveiling of the statue took place upon the 21st of May, 1872, and the inauguration was attended by a most influential circle of guests, and during the proceedings Mr. Ramsden took the opportunity of presenting those public baths to which we have already had occasion to refer. During the ceremonies speeches were delivered by many eminent gentlemen, among

others by the Duke of Devonshire, who said:—"I have in my mind various critical periods in the history of Barrow, when opportunities presented themselves which, if foregone at the time, would probably never have recurred, and it was mainly to Mr. Ramsden's advice on those occasions, to the foresight he exhibited, to his power of foreseeing and urging those connected with Barrow to take advantage of those opportunities, as well as his steady perseverance in making use of those opportunities when acquired, that the prosperity which Barrow has achieved is mainly to be attributed. It is true that Barrow has great natural advantages, and that to Mr. Ramsden is only due the credit of having perceived them and made the best use of them. I cannot conceive that any greater credit is due to any one than to say he had the good sense to make a good use of those powers by which he is surrounded. (Applause.) The world is, we all know, full of instances of great resources neglected and unheeded; not a few instances of such may be found in our own country, and there are many present who can confirm the truth of this observation. I may be allowed to refer to another of Mr. Ramsden's qualities, scarcely less valuable than that to which I have already referred. He has never allowed himself to be discouraged or faint-hearted when immediate prosperity did not seem so encouraging as might have been desired; and although the progress of Barrow and Furness generally has on the whole been remarkably steady, there undoubtedly have been periods, as there have been in everything else, of depression; periods when, if I am not mistaken, many of those who thought they knew most of the state of the affairs of the district were convinced that the prosperity of Barrow would vanish as rapidly as it rose. I can bear witness that Mr. Ramsden never gave way to such melancholy anticipations. (Renewed applause.) He was always thoroughly convinced that Barrow had the elements of success in itself, which though they might be checked for a moment must render it in the end, and at no distant period, a place of very great importance. (Applause.) His anticipations, so far as the past is concerned, have been verified by experience; and as to the future, although undoubtedly no reasonable man would expect that Barrow should continue always to enjoy the same degree of remarkable prosperity which it has met with during the last few years, yet I believe its position as an important town, and as a place of trade, is now established on such a firm foundation and so sure a basis, that no reasonable doubt can be entertained of its continued growth and prosperity. . . . . I may truly say that wherever the name of Barrow has penetrated the name of Ramsden is connected with it, and the conviction of his indefatigable exertions in promoting its prosperity. . . ."

The statue, eleven feet in height, represents Mr. Ramsden in the robes of office as Mayor of Barrow. It is a fine work of art, and the likeness is admirably preserved. His features, which are very characteristic, are reproduced in great fidelity. The pedestal, an admirable specimen of masonic art, is panelled on the two sides with representations of Barrow in 1846 and in 1871. From the surplus of the funds at their disposal, the committee resolved that a handsome statuette in white marble, a facsimile of the statue, should be presented to Mrs. Ramsden, and that Mr. Knight, R.A., should be commissioned to paint a portrait of Mr. Ramsden, to be hung in the Town Hall.

So much for local recognition. But on the 25th of June, 1872, Mr. Ramsden received a national acknowledgment of his worth, for he was knighted by the hands of Her Majesty Queen Victoria, at Windsor Castle.

We have endeavoured throughout to avoid any infringement upon the privacy of personal character; we may, however, state that Sir James married a daughter of Mr. Edwards, an eminent Liverpool merchant, and that by her he has a son and heir. His private character is well known to all his friends and acquaintances, and can be but of slight interest to others. In addition to the honours we have before mentioned, we may state that Sir James Ramsden is a Justice of the Peace for the counties of Cumberland and Lancashire, Deputy-Lieutenant for Lancashire, and Lieutenant-Colonel of the 5th Battalion of Lancashire Volunteers. Year by year he has been re-elected to the civic chair of Barrow, an honour that this year he was compelled to forego, as he had received a greater homage to his value in the shape of a summons to become High Sheriff of the county of Lancashire. He is also a chairman and director of several local companies, and has quite recently been elected director of the "Grand Trunk of Canada."

For the facts in our article we are indebted :—

1.—To private information and local knowledge.
2.—To "The Rise and Progress of Barrow-in-Furness," by Francis Leach, Esq., B.A.
3.—Baines' "Lancashire, Past and Present."
4.—"Furness, Past and Present."

REPORT ON BOILER INCRUSTATION.

Hannibal, Mo. *May*, 1872.

To the American Railway Master Mechanics' Association :

GENTLEMEN,—The Committee to whom it was your pleasure to again refer the subject of Boiler Incrustations, their Causes and Cure, would respectfully report that they have given the matter as serious a consideration as the time and its great difficulties would permit.

In accordance with former practice, circulars of inquiry have been addressed for information to various parties, but to such only as might have something to offer, from investigations made since our last annual meeting. We regret that no new or important information has been elicited, throwing additional light upon the subject; your Committee being therefore unable to present any new facts, will have to confine itself to an allusion to the experiments which have been going on for the past two years, and also to speculation upon the relative cost of purifying water before it is taken into the boiler, if, indeed, such a thing can be accomplished at all. In justice to Mr. J. H. Setchel, who has written at considerable length on the subject, the Committee would suggest that his communication be read in full.

The use of pure water is universally recommended as being the only effectual remedy. Some, however, are still experimenting with fluids, powders, batteries, &c. It will be remembered that the plan, or a similar one, recommended last year by Mr. S. J. Hayes, of the Illinois Central Railroad, was indorsed by the Committee, and embodied in their report as the fundamental principle through which this great evil can only be effectually overcome. It is the opinion of your Committee that the impurities contained in water will precipitate sufficiently for practical purposes after a certain amount of boiling, but whether this method of purifying can be made practicable and cheap is a question which we cannot from our own experience determine. We are not prepared to believe that chemical means alone can be economically employed for the precipitation of the materials in water which form incrustations; but to this we shall again refer. A subject which has so long baffled the skill of the leading scientific and practical minds at home and abroad, cannot be properly treated without reaching in vain after the necessary data to make the article wholly reliable and conclusive. We think so great an evil as boiler incrustations, involving in its range violent explosions, loss of life, and great destruction of property, should have the combined effort of scientific and practical men towards the development of a remedy; and to this your Committee, fully realizing the extreme difficulties of the subject, have invited the co-operation of eminent chemists and scientists, and from them they have not as yet obtained anything sufficiently definite to warrant its presentation, and hence they feel that the only way left open to them by which they can discharge their duty to themselves and the Association, who have honoured them by their appointment for this particular office, is to present their own crude and imperfect ideas and experience for what they may be worth. It was thought that enough was said upon this subject last year to stimulate an interest on the part of railway companies in the matter of purifying water before using it in their engines, but we have failed to hear of any experiments in that direction.

Your Committee do not believe a remedy can be devised without more or less experimenting, all of which must necessarily be attended with considerable expense; but they will endeavour to show that at least some economy may be the result.

The plan which we shall attempt to explain is one which we believe will nearly if not quite purify the water before it is taken into the boiler, and it is yet hoped, by the introduction of chemical agents, that this method may be simplified and prove practicable and cheap. Not having tried any experiments in this direction ourselves, we shall be confined to the experience of others to prove our theory, and will first refer to a paper prepared as a report of experiments made by Professor C. F. Chandler, of Columbia College, New York, to the President and Directors of the New York Central Railroad Company upon the various kinds of water used by the locomotives of that Company along the line of that road, with an analysis of the waters, showing their composition, and also an analysis of the scale formation from such waters, and what chemical agents and processes would decompose and prevent the same. The report was read before the American Institute Polytechnic Association, January 11, 1866.

The following article appears in this report :— "Boiling expels

the free carbonic acid and causes the separation of the carbonates of lime and magnesia, and if conducted at a high temperature, under considerable pressure, results in the almost complete precipitation of the sulphate of lime. This would, however, merely transfer the incrustations from the locomotive boiler to some other vessel, and would, therefore, be valueless in this case." This is just what we desire to do, transfer the incrustation from the locomotive boiler to some other vessel provided to receive it and so arranged that the sediment may be removed at pleasure. Then supervenes a difficulty in the use of chemicals for precipitating the lime, &c., from the water, which seems to offer two insuperable objections. The first found is in the nature of the chemicals used; for, whilst precipitating the matter forming incrustations, they may corrode the metal itself. All chemicals would have to be used to purify the water before entering the boiler, in order to avoid this corrosion and also the precipitation into it, which would still demand cleansing of the foreign matter. Then a second objection arises out of the wide differences of water in the different sections; whilst incrustations are formed from those which contain lime, yet there may be and is such a difference of chemical admixtures as to render it wholly impossible to find any one universal chemical sufficient to dissolve these different elements. Hence we feel the necessity of looking somewhere else than to chemical solvents alone for a solution of the difficulty.

If Professor Chandler's theory be correct, an apparatus can be easily arranged at each water tank along the line of the road by which the water may be heated, and if desired subjected to a pressure, before being taken into the locomotive boilers. From his statement we may assume that the impurities in water will precipitate at a temperature of two hundred and twelve degrees; if this be true, the best and cheapest method of heating the water to this temperature, and its treatment after being so heated, only remains to be proven, and your Committee would suggest the following plan: Let each watering station on the line of the road be provided with a pumping-engine or steam-pump, with a capacity in proportion to the amount of water required. The exhaust steam from the pump should be conducted into a suitable heater, together with as much live steam as may be necessary to raise the water to a boiling heat. The heater being closed, the water within it at the boiling point would be subjected to a pressure of about fifteen pounds to the square inch. The heater should be made of iron, and as large, perhaps, as one-third the capacity of the tub. While the heater is being filled the water should be raised to the boiling point, after which the calcareous and other matter in suspension should be allowed time to settle, when the water can be drawn off into the tub arranged to receive it. After the heater is emptied the sediment may be blown off, and this process repeated until the tub is filled, thus keeping up the supply of purified water according to the demand.

The expense attending this apparatus would be equal to the cost of a No. 4 Knowles steam boiler and pumps complete—$450—together with the heater and its fixtures all told would not exceed $1,000; and deducting from this amount the value of the present machinery employed, consisting of one ordinary horse-power and a four-inch hand or power pump, would make actual expense of first cost at such watering station about $800. The second cost, or continual expense, may be estimated in proportion to the amount of fuel consumed for the purpose of heating the water. Assuming as a basis that one pound of coal will evaporate eight pounds, or one gallon of water, we would only have to estimate the amount of coal consumed to arrive at the approximate consumption of water. It has been proven by experiment that if five and a-half pounds of water, at a temperature of thirty-two degrees, be placed in a vessel communicating with another in which water is kept constantly boiling at the temperature of two hundred and twelve degrees, until the former reaches the temperature of the latter quantity and is then weighed, it will be found to weigh six and one-half pounds, showing that one pound of water has been received in the form of steam, through the communication, and reconverted into water by the lower temperature in the other vessel. Now this pound of water received in the form of steam had, when in that form, a temperature of 212°. It is now converted into the liquid, and still retains the same temperature of 212°, but it has raised five and one-half pounds of water from this temperature of 32° to 212°, and this without losing any temperature of itself. It follows, then, that in returning to the liquid state it has parted with five and one-half times the number of degrees of temperature between 32° and 212°, which is equal to 180° and 180° × 5½° = 990°. Now this heat was combined with the steam, but as it is not sensible to a thermometer it is called latent heat. It is shown, then, that a pound of steam in passing from a liquid at 212° to steam at 212° receives as much heat as would be sufficient to raise it through 990 thermometric degrees, if that heat, instead of becoming latent heat, had been sensible, and 990° + 212° = 1202°, being the whole amount of heat in steam. Hence it will be seen that one pound of coal, capable of evaporating eight pounds of water, will raise to the boiling point about five and one-half times as much, say forty-four pounds, or five and one-half gallons of water. To this must be added the relative value of the exhaust steam from the pumping engine, which will be equal to five and one-half times the amount of water evaporated in pounds. Supposing, for example, that one locomotive running 2,600 miles a month, or 31,200 miles a year, will make 45 miles to one ton of coal; it would then consume 693 tons of coal per year, at $2·50 = $1,732·50. If this locomotive will evaporate six pounds of water to one pound of coal, it will require 8,316,000 pounds, or 1,039,500 gallons of water. It is estimated that a No. 4 Knowles steam-pump will raise 5,940 gallons of water an hour. In doing this work it will consume about sixty pounds of coal, requiring 10,500 pounds to pump the whole amount of water. If the pumping engine will evaporate eight pounds of water to one pound of coal, the exhaust steam will boil about five and one-half times this amount, or forty-four pounds of water to one pound of coal, equal to 10,500 × 44 = 462,000 ÷ 8 = 57,750 gallons. This would leave 981,750 gallons to be boiled by the use of live steam from the boiler, which will require one pound of coal to five and one-half gallons of water, or 981,750 ÷ 5½ = 178,500 pounds coal ÷ 2,000 = 89 $\frac{250}{1000}$ tons. This, added to the amount of coal required to pump the water, would make about 94 $\frac{550}{1000}$ tons, at $2·50 = $236·25, total expense for fuel in purifying the water in one engine for one year. Boiler repairs, including machinists' labour in taking down and setting up machinery that would not be otherwise done, would amount to about $550 a year. Of this amount fully sixty-five per cent. may be due to incrustations alone. Judging from reports received by your Committee from Eastern and Southern roads using water from which no incrustations form, where boilers run from fifteen to twenty-seven years without repairs, it may be safe to assume that even seventy-five per cent. will be saved by the use of pure water. But granting that only sixty-five per cent. is saved, the actual cost of boiler repairs due to incrustations would then be $357·50.

We will now consider the extra amount of fuel necessary to heat the water through the increasing formation of incrustations, which we will attempt to illustrate as clearly as possible, from the best information we have been able to gather, from both theory and practice. Dr. Joseph G. Rogers, in a paper on steam boiler waters and incrustation before the American Association for the Advancement of Science, says:—"The evil effects of scale are due to the fact that it is relatively a non-conductor of heat. Its conducting power compared to that of iron is as 1 to $\frac{17}{15}$. This known, it is readily appreciated that more fuel is required to heat water through scale and iron than through iron alone. It has been demonstrated that a scale $\frac{1}{16}$ of an inch thick requires the extra expenditure of fifteen per cent. more fuel. As the scale thickens the ratio increases. Thus, when it is one-fourth of an inch thick, sixty per cent. more is required; at one-half inch, one hundred and fifty per cent., and so on. To raise steam to a working pressure of ninety pounds the water must be heated to 320° Fahrenheit. This may be done through a one-fourth inch iron shell by heating the external surface to about 325°. If a one-half inch scale intervenes, the boiler must be heated to 700°, almost a low red heat. The higher the temperature at which iron is kept the more rapidly it oxidizes, and at any temperature above 600° it soon becomes granular and brittle from carbonization or conversion into the state of cast-iron. Weakness of boilers thus produced predisposes to sudden explosions and makes expensive repairs necessary."

On most of Western roads incrustations will form to a thickness of from one-eighth to three-sixteenths of an inch in the course of one year, and increases at a still greater ratio as long as the engine is kept in service. Thus, after four months' time, there will have accumulated in our engines nearly one-sixteenth of an inch of scale. This statement will be verified by a specimen presented for your inspection, consisting of a piece of two-inch flue taken from an engine on the Hannibal and St. Joseph Railroad after three months' service, to which is adhering a scale nearly one-sixteenth of an inch thick. If Dr. Rogers' theory be correct, after one month's service our engines will consume three and one-fourth per cent. more fuel than at first; after two months', seven and one-half per cent., and so on, making an average for the year of over twenty per cent. more fuel than they would have consumed if using pure water. This, according to the performance of the best coal-burning engines, making forty-five miles to one ton, will amount to an extra expenditure in fuel of not less than 138½ tons at $2·50, making $346·25 due to incrustations. This, being added to the expense of repairs due to incrustations, will make $703·75. In addition

to this the expense of washing boilers may be counted; as by the use of pure clear water boilers will seldom require washing, and the expense of at least $1 per week or $52 per year, would be saved to every engine, swelling the total to $755·75, or $519·55 more than the cost of purifying the water by this process. From this it will be observed that to boil sufficient water to supply a locomotive for one year, running 31,200 miles, will require the extra expenditure of $236·25 for fuel. Now, if boiling alone will purify the water, there would be a saving of $519·50 to each engine, or $51,950 for one hundred engines. Besides all this the use of pure water will absolutely prevent all manner of explosions, ruptures and leaks, arising from the effects of incrustations. It will also save a large proportion of the repairs to the machinery, not counted in the above estimate, by always supplying the cylinders with pure dry steam of the best quality, free from loose sediment or grit, which always follows the course of the steam, frequently cutting the valves, pistons and cylinders, and otherwise damaging the machinery of the engine. The use of water free from mud and organic substances will absolutely prevent the evil of foaming, which so frequently almost unfits an engine for usual services, until it can reach its destination and be washed out. This and many other prolific evils arising from the use of impure water would, beyond a doubt, be entirely overcome. The introduction into a boiler of any so-called remedies, be they powders, batteries, fluids, or any other nostrums, can hold no comparison whatever to this one perfect and only reliable remedy. Any experiments towards the providing of pure water for locomotive use is a step in the right direction, and when railway companies are aware of the fact that in the Middle and Western States the expense due to impure water and incrustation would amount to the enormous sum of about $75,000 a year for every hundred locomotives, we think they can afford to give the subject a little consideration with a view to making some practical experiments by which reliable and satisfactory results may be reached. The matter of thoroughly purifying the water at a moderate expense is so extremely difficult, that your Committee are not prepared to suggest any particular plan other than that already recommended, believing that nothing in this direction can be definitely known without more or less experimenting.

Mr. Towne, of the Hannibal and St. Joseph Railroad, has been investigating for the past two years with an apparatus consisting of an ordinary dome, 25 × 25 inches, riveted to the top of the boiler in a convenient locality to the pumps of the engine, so that the water supply can pass freely through the check pipes to the top of the dome, where it is discharged and caused to fall upon and ripple over a series of heated plates, circular in shape, provided with a series of ribs or stops on their upper surfaces to retard the momentum of the water, and arrest the sediment as it passes from one plate to another in its course to the boiler. After passing over these plates the water forces its way through a filter, thence to the boiler through a number of one-inch pipes, through which also steam from the boiler is admitted to the dome, distributing itself around and within the heater, maintaining a constant equilibrium of heat between the apparatus and the boiler. Half of these plates are slightly convex and half concave, causing the water to flow from centre to side and side to centre alternately, passing through holes or slots in each plate on its way to the filter, and finally to the boiler through said pipes, which extend upwards about five inches, forming on top of the boiler (within the heater) a basin for water and a receptacle for any sediment that might lodge there, whence it could be blown off by means of pipes arranged for the purpose.

The filter was composed of coarse gravel, and soon found to be of no practical use beyond the lodgment of more or less incrustation. The shelves were found to gather from one-sixteenth to three-sixteenths of an inch of incrustation in from six to twelve weeks' time, showing clearly that the principle was correct, but the apparatus entirely too small to arrest all the lime, as the boiler and flues were also found to be thickly coated, especially so directly under the heater; where the water had fallen upon the flues, scale had formed from one-fourth to three-eighths of an inch in thickness. After running this engine about sixteen months without any satisfactory results beyond that already stated, it was taken in for temporary repairs, and the heater re-arranged with a view to getting the greatest possible amount of heating or plate surface within its capacity. The filter was accordingly taken out, and the boiler cut out to the size of the internal diameter of the dome, and an additional number of plates put in, about one and a-half inches apart, filling the dome full, making sixteen plates in all—a plate surface of about fifty superficial feet. In addition to this a circular strip of sheet iron, four feet long, was placed inside the boiler, directly under the heater, its ends being flanged upwards about two inches, filling the circle of the boiler, and its sides extending downwards to within a few inches of the bottom of the boiler. This was to prevent the water from the heater coming in contact with the flues, and also to provide a still greater heated plate surface, over which the water must travel before reaching the boiler, making, all told, about eighty-two superficial feet of heating surface. The engine is now running with this apparatus, and although it arrests so much lime and mud that it is found necessary to take out the plates and clean them off occasionally, yet it does not seem to stop all the incrustations, and consequently it is not just the thing. Judging from these experiments, as well as others, we do not believe that any apparatus of this kind can be got on to an engine of sufficient capacity to purify the large amount of water required for a locomotive boiler. We think the same device, or a similar one, arranged at watering stations along the line, on a larger scale, might be made to do the work effectually at less expense perhaps for fuel than the first plan. If not by that alone, the introduction of chemical assistants, at a trifling cost, might have the desired effect. The first plan, however, would seem to be the most feasible. The importance of this subject cannot be overrated, since it is known that among the many evils of incrustations none are more potent than the fact of boiler explosions from this cause, and nothing can be surer than pure water as a remedy for this class of explosions. There are cases of explosions of boilers at pressures that, without proof to the contrary, may be taken to be very much below their power to resist pressure, showing very clearly that boilers do explode from causes yet unknown. It is, then, reasonable to suppose, since the fact is not known, that impure water and incrustations may be the source of this unknown element of destruction. Should it be, however, only one cause of such terrible disasters, one point will have been gained; for a single remedy absolutely known is worth more than all the speculative theories extant, as it may lead to the development of a final cure, and in time boiler explosions, other than those caused by low water and over-pressure, will no longer be a mystery.

In conclusion, your Committee feel that they are groping in the dark, and cannot conceal from themselves what must be apparent to others, that the question is yet an open one, and whether the theory advanced will effect a complete solution of the difficulty yet remains to be proven by actual trial. To this end we would respectfully invite the attention of all interested, and recommend a series (if possible) of exhaustive experiments, without which they are convinced nothing definite in this direction can ever be known.

Respectfully,

H. A. TOWNE, *H. & St. J. R. R.*,
J. JOHANN, *P. R. R., of Mo.*,
J. M. BOONE, *P. F. W. & C. R. R.*,
Committee.

In connection with this report the following letter from J. H. Setchel, Little Miami Railroad, was submitted and read :—

MR. SETCHEL ON BOILER INCRUSTATIONS.

H. A. Towne, Esq., Chairman Committee
on Boiler Incrustations :

DEAR SIR,—Originally the water on this road was all very hard; but since the introduction of coal as a fuel the necessity of soft water has been so apparent that strenuous efforts have been made to obtain it.

At Cincinnati the water of the Ohio River is used, and but little incrustation is found in boilers using this exclusively; and even after engines have run on other divisions and have become heavily scaled, a year or two's use of this water will in a great measure remove it.

At Columbus the water of the Scioto River is used, and with about like results. Within the two points named, where the water is mostly taken from wells, it is highly impregnated with lime, forming on flues and boilers a hard, flinty scale. On one division, of fifty-seven miles, we have more trouble than on any other part of the road. Here the water is taken from wells and is very hard; and in running this division we can take engines upon which we are required to do more or less flue work every few weeks, and by transferring them to the main line we are enabled to run them without difficulty. I can account for this only on the score of the difference in the quality of water used.

We do not take out flues for the purpose of cleaning them, but run them as long as they can be kept tight. Copper flues, in engines burning wood, will run from 150,000 to 200,000 miles. Iron flues, in engines with coal as a fuel, will average from 50,000 to 80,000 miles. We find that the life of the bottom part of boilers seemingly varies with the quality of iron used. We sometimes find a new boiler eaten out in spots in the bottom part after running three years. This I attribute, to some extent,

to the rough places often left in iron by using too much sand on the rollers while the iron is in process of manufacturing. In forming sheets into shape this sand that has been pressed in the iron often drops out and leaves a thin, rough place in the sheet, to which the scale adheres and enters on the work of destruction, and subsequently forms the eaten places for which the bottom sheets are taken out. I know the destruction of the bottom part of boilers is often attributed to scale and vegetable matter held in solution in this part of the boiler; but, when you learn our method of cleaning boilers, I think you will agree with me that this can hardly be the case here. I have tried most all the "sure remedies" for preventing and removing scale that have been in vogue for the last five or six years without any positively good result. I have used John Bull's scaling powder in boilers that were thickly coated, and have found that it will remove scale to a noticeable extent. The engines would steam better and large quantities of scale and mud would be taken from the wash-out plugs for a while; but, in my experience, I find that at certain seasons of the year our boilers will scale more or less without any artificial means being used. Our freight engines are run one hundred and twenty miles four days in the week. This gives two lay-over days, and on one of these days the water is let out of the boiler when comparatively cold, and the bottom part of fire-box is thoroughly cleaned of all mud and scale. A two-inch hand hole plug is placed at each corner of fire-box that readily admits of the introduction of rods and hose nozzles for this purpose. In the front end, at bottom of flue sheet, is another hand-hole plug large enough to admit of a rod with auger or hook-shaped end. Once every two weeks this plug is removed and the cylinder part of boiler is thoroughly washed together with the leg of fire-box as before. This process keeps the boiler free from mud, but does not, of course, prevent the formation of scale. To effect the latter I have tried almost everything. Of the mixtures to put inside for the purpose of removing scale I have found none better than the one before mentioned—"John Bull's." I am now experimenting with Hay's "Galvanic Battery" on three boilers; but it has not yet been in use a sufficient length of time for me to form any opinion as to its merits. I know of nothing that will effectually prevent the formation of lime in boilers. I should think that, where water is used containing sand or vegetable matter in solution, a filter might be useful in arresting such impurities. Some years ago we were a great deal troubled by the filling up of the space between the crown-bar by deposits of mud and scale, but since the practice of giving an inch clearance under the bar has been adopted, and the quality of water been improved, we have little or no trouble from this cause.

Respectfully yours,

J. H. SETCHEL,

Master Mechanic, Little Miami Railroad.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

A REGULAR meeting of this society was held at the rooms in New York, March 5th, 1873.

A Paper on "Shaw's Gunpowder Pile-Driver" by Samuel R. Probasco, Civil Engineer, of Brooklyn, New York, was read.

This pile-driver was set at work in October, 1872, on a line of sheet-piles for a reservoir dam in the valley of Parsonage Creek, Long Island. The material to be penetrated was sand and fine gravel, cemented together in places, so as to be hard and difficult to move with a pick, and like "hard-pan." Clay was found below the water level of the basin, some borings showing it at 15 ft. below the surface; the lower stratum was tough and tenacious and the whole material was under water.

The machine in form resembles an ordinary pile-driver. A cast-iron block, called a "gun," resting on the head of the pile, is bored out, and receives without windage a wrought-iron piston attached to another cast-iron block, called the "ram," which is lifted by explosion of powder in the bore. When the piston leaves the gun, a cartridge is thrown in, which, exploded by the heat freed by the piston in its descent, throws the ram upwards again, and forces the pile downward. The area of the piston is adjusted to the weight of the ram, which also is adjusted to the work to be done. Soda-powder cartridges in cylinders of $1\frac{1}{4}$ to $1\frac{1}{2}$ oz., coated with blacklead and paraffin, are used. The coating is expected to keep the powder dry, lubricate the gun, preserve the requisite tightness, prevent escape of gas, and cause the entire force to be exerted on the base of the piston. The piston is made a little smaller than the bore of the gun, and has on its lower end a steel ring which fits the bore closely. The performance was as follows:—At first several explosions were necessary to lubricate the gun, which leaked gas so that the ram would not go to the requisite height to move the pile. After a few shots the piston moved up regularly, and, in its descent, fired the charge, forcing the pile down and itself upward.

When the resistance is slight this machine may be economical, but when, as in this case, it required 300 blows from cartridges costing $2\frac{1}{2}$ cents each to force a pile down 15 or 16 ft., it cannot be called so.

The gas from the explosions cut passages in the ring at the end of the piston, and thereby much lessened the power of the machine. The gun became hot from the rapid discharges, and the bore enlarged, whereby more gas escaped.

Seven piles were driven with it—each costing more for powder than the contractor got for the piles in place—when the machine refused to work. On examination, the steel ring was found furrowed by the powder, and the piston (diameter 5 in.) so bent, by striking the bottom of the gun, as to be useless. The air cushion relied upon to prevent this was lost by the furrowing of the ring.

The inventor, on being consulted, decided that the excessive consumption of powder was due to the piston being too small for the ram, weighing over 1,700 lbs.

The bore of the gun was then enlarged to receive a piston of 7 in. in diameter, and ten piles more were driven, when the machine was again laid aside.

The result of this trial was similar to the first, except that the piston was not bent. The gun got so hot as to fire the powder before the ram reached its place. Altogether seventeen piles were driven to a depth of from 14 to 19 ft., requiring from 200 to 300 blows of $1\frac{1}{2}$ oz. cartridges.

An ordinary pile-driver was then employed, with a hammer weighing 1,800 lbs., and falling 8 to 10 ft. In this way eleven piles were put down $15\frac{1}{2}$ ft. in ten hours, costing per pile no more than 100 blows from the powder machine. These 100 blows at best would put the pile down but 10 ft.

The piling was spruce, from 10″ × 10″ to 10″ × 14″; 20 feet long, with 2″ square tongue and groove.

The piles were bevelled at the point on three sides, leaving the grooved side untouched. The groove was driven on the tongue of the preceding pile. The heads were protected with a light band. Seven piles were driven without shoeing; the eighth split and showed the necessity of protection at the point. A cast-iron cup shoe, weighing about 40 lbs., with a groove in it, and made with three bevels and one plain side, was found to stand the work.

The tendency of the tongue of the pile to work up was obviated by twisting a chain tightly about the pile and tongue; a lever with rope attached was used for this purpose, the force being applied as the blow was delivered. Seventy-five piles were driven in this way to a mean depth of $15\frac{1}{2}$ ft. By experience 6″ more depth has been attained, which is about the maximum penetration to this kind of material, and this can only be done with the best of sound dry spruce.

A brief discussion followed, after which, a paper on "Rail Economy," by C. P. Sandberg, C.E., of London, England, in reply to the discussion had upon a former paper of his on the same subject, was read.

In that discussion it had been remarked, under the head of "Traffic Capacity," that the weight on locomotive driving wheels stated therein differed from American practice; that on the Philadelphia and Reading Railroad 4 tons on drivers were not exceeded for a 64 lbs. rail, and that on the Erie Railway $5\frac{1}{2}$ tons had been found too much for a 70 lb. rail.

Mr. Sandberg herein replied that it would be interesting to know what weight the rail and the rail joint would carry in the two instances mentioned. $6\frac{1}{4}$ tons on drivers on a 60 lbs. rail, as stated in the table, and considered excessive, might not be so; the table showed that the 60 lbs. rail of standard section, with fish-plate, would carry 14 tons in the middle between 3 ft. bearings, and $9\frac{1}{4}$ tons at the joint between 2 ft. bearings. According to the table, the maximum load on drivers on standard sections was one-third what the rail in the middle would carry, and two-thirds of what the rail joint would sustain. In order to obtain the full value of the material, the joint ought to be as stiff as the middle of the rail. For this it is best to use the fish-plate as thick as will not interfere with the tire-flange, the angle should be as small as will permit an easy rolling of the rail. This angle is 11° and 15°—the latter for light rails—experiments having proved that the smaller the angle the stiffer the joint. With this fishing, the capacity of the rail at the joint is two-thirds that at the middle, while with ordinary fastenings it is but one-fourth. In regard to the Erie sections, experiments have shown that this rail will bear at the joint but 2 tons, while

at the middle it will carry 10 tons; hence it is not strange that 5½ tons on the drivers proved disastrous.

The necessity of sufficient thickness in the fish-plates is often overlooked. It is doubtless prudent to increase the number of drivers on American roads, but the statement that 6½ tons on a 60 lbs. standard rail section, with standard fastenings, is excessive, should be modified. This load is not the most economical for working a line, but that to which an increase of traffic might extend. Many European railways with a 70 lbs. section have a joint carrying only 6 tons, owing to too large an angle and too thin a fish-plate.

TOBACCO-PIPES AND SMOKING APPARATUS.

THE series of industrial displays held annually, under the general name of the London International Exhibitions, has this year afforded us an opportunity of observing how widely spread and curiously developed are the industries connected with the indulgence of smoking. We may approve or disapprove of this indulgence; we may admire or smile at King James's "Counterblast to Tobacco;" and may or may not wish success to the anti-tobacco movement; but we cannot conceal from ourselves the fact that many branches of trade are interested in the matter; that much money is thereby circulated in nearly all countries of the world; and that considerable taste and ingenuity are displayed in fabricating the apparatus which facilitates the inhalation of narcotic fumes by the smoker. All grades of civilization, from the lowest to the highest, are concerned in it. Any simple tubular arrangement will suffice for this inhalation. Some of the natives of British Guiana use the rind of the fruit of the areca-palm coiled up into a kind of cheroot, with an internal hollow to hold the tobacco. The poorer Hindoos make a simple pipe of two pieces of bamboo, one, cut close to a knot, for the bowl, and a more slender piece for the tube. A lower class of natives in India make two holes of unequal length with a piece of stick in a clay soil; the holes are unequally inclined, so as to meet at the bottom; the tobacco is placed in the shorter hole, and the smoker, applying his mouth to the longer, inhales the fumes in this primitive fashion. The pipes used for opium smoking in various parts of the East have small bowls; the drug is too costly to be used otherwise than in small portions at a time, and too powerful to need more than a few whiffs to produce the opium-smoker's dreary delirium. The Tunisians use reeds for pipes. Stone pipes are found among the natives of Vancouver; while "Strong-bow," the North American Indian chief, has his long wooden pipe of peace decked out with tassels and fringes, but with an ominous-looking sharp steel cutting instrument near the end most remote from the bowl. Chinese, Japanese, Philippine Islanders, Madagascans, Central Africans, Algerine Arabs, Mexicans, Paraguayans, Siamese, Tahitians, South American Indians, Mongols, Malays, Tartars, Turcomans, as well as the nations of Europe, and the chief nations of Southern Asia, all have their smoking pipes, plain or ornate, as the case may be, and made of wood, reeds, bamboo, bone, ivory, stone, earthenware, glass, porcelain, amber, agate, jade, precious metals and common metals—according to the civilization of the country and the pecuniary means of the smoker.

Tobacco, as is well-known, is the chief vegetable substance smoked; although other leaves and fibres are sometimes used, and opium to a really frightful extent in some parts of the East. Cigars and cigarettes, of course, supply pipe and tobacco at once. The sailor's quid is out of court; he chews but does not smoke it.

Without going into the characteristics and cultivation of tobacco, and setting aside snuff and its associations, we may take a rapid survey of the industries concerned in the manufacture of smoking-pipes generally.

English Clay Pipes.

It is supposed that the familiar English pipe came into use soon after the introduction of tobacco into this country; but it is certain that many other contrivances were in use in the seventeenth century besides the clay bowl and stem. Silver pipes were used by the rich, while the humbler class often contented themselves with a walnut shell and a straw. Tobacco was rather costly at first, and at the evening gatherings of working-men one pipe was made to serve all, each taking a whiff in turn. Other kinds of herb or leaf, it has been clearly ascertained, were smoked long before tobacco was known amongst us; coltsfoot, yarrow, mouse-ear, lettuce, &c.; and the smokers often used a primitive pipe made of a clay bowl, dried at the kitchen fire, and fastened to the end of a stick of elder from which the pith had been removed. White clay pipes, something like those now made, have been dug up in various parts of Britain, and are known as Danes' pipes, Celts' pipes, &c.; but the best authorities do not believe them to be many centuries old. The clay pipes made in England between the time of Elizabeth and of the Commonwealth underwent many changes of form. The earliest bowls were rather narrowed at the top, as if the better to retain the tobacco; to this succeeded a barrel shape, a sugar-loaf shape, a crock shape, and then a bowl very long in relation to its width, and considerably curved.

The common English tobacco-pipe of our own day—the "yard of clay,"—is an ingenious but by no means highly finished production as an article of manufacture; novelty is seldom thrown into it, and the implements employed are so simple, that men of small means can readily enter the trade as manufacturers. The pipeclay employed is mostly obtained from the neighbourhood of Purbeck. It is picked, ground, sifted, washed, and rolled into lumps of 100 lbs. or so each. The moulder, cutting off pieces each large enough for one pipe, rolls them out on a table, contriving that one end of each shall be more bulbous than the other. When slightly stiffened by drying, one of these is taken into the left hand of the workman, who dextrously thrusts a wire through it from end to end, feeling his way with the fingers of his left hand. A metal mould hinged in two halves is slightly brushed with oil, and the clay (impaled on its wire) placed within it. A squeeze in an iron press brings the clay into the form of a pipe, with bowl, ornamental device, &c., in their proper places; the bowl is finished by means of the finger and a moulding-plug. Small irregularities are cut away with a knife; additional ornaments (for the best pipes) are produced by means of small rollers and stamps, and the stems are polished with pieces of bone or hard wood. The pipes are set aside on shallow trays to dry. They are baked or fired in fire-clay crucibles, in which they are so ingeniously built up that six or seven hundred can be ranged in each crucible without touching one another; several such crucibles are placed in a circular brick-kiln, and there heated until the pipes are sufficiently baked. Impure pipeclay sometimes results in a dirty reddish hue being given to the pipes; to remedy this defect, the pipes, during firing, are exposed to the action of smoke, the carbon of which converts the red oxide of iron (the chief impurity) into another oxide almost colourless. The magnum pipes called "aldermen," the Irish "doodeens," the Scotch "cutties," and the twisted pipes, are mere modifications of the common tavern pipe. The best pipes are moulded a second time before quite hard, and polished by passing the stem to and fro through a hole bored in a piece of agate or flint. (The processes were very well shown at the International Exhibition, in 1871.) Whether it is so now we do not clearly know, but a few years ago more clay tobacco-pipes were made at Glasgow than in any other part of the kingdom, the daily make being 2,700 gross, or 120 millions per annum. Broseley, in Shropshire, is another busy pipe-making town.

French and Dutch Clay Pipes.

The French clay pipes have quite a special character; they are well-made, and great ingenuity is shown in the preparation of the moulds in which they are pressed; but being mostly intended for a class of purchasers who prefer grotesque ideas to refined taste, the bowls are often ornamented with queer-shaped heads, having bead-like eyes; sometimes imaginary beings, sometimes caricature portraits of eminent persons. Where more than the head is represented, license is occasionally given to a certain grossness of idea; but this is not a general characteristic. The clay of which these French pipes are made is admitted to be superior to that of England, due to the careful mixture of different kinds, and to skilful manipulation. St. Omer is a notable centre of this branch of industry. Even twenty years ago, one manufacturer in that town employed 450 workpeople, and produced 15,000,000 pipes a year; while another gave employment to nearly twice as many hands, turned out 30,000,000 pipes a year, and used up no less than 8,000 tons of clay in so doing. The commonest of these pipes are sold at the rate of one penny a dozen. In the department of Pas-de-Calais, chiefly at St. Omer and Arras, the pipe-makers (chiefly women and children) number between two and three thousand.

We need not say much about Dutch pipes as distinct articles of manufacture, because the processes adopted in their production are pretty much like those in use elsewhere. The Dutch are famous clay-pipe smokers, not countenancing the cigar so much as their neighbours the Belgians, nor the meerschaum so largely as their German neighbours on the Rhine frontier. A notable bit of sharp practice is on record in connection with the pipe-makers of Holland; a dodge only to be justified on the

equivocal maxim that all is fair in trade provided it just keeps within the margin of the law (of those who venture beyond this margin we need not speak). A pipe manufactory was established in Flanders about the middle of the last century. The Dutch makers, alarmed at the competition which this threatened, cunningly devised a stratagem for nipping it in the bud. They freighted a large worn-out ship with an enormous quantity of pipes of their own make, sent it to Ostend, and wrecked it there. By the municipal laws of that city the wreck became public property; the pipes were sold at prices so ridiculously low that all the townsmen were glutted with the commodity; the new Flemish manufactory was thereby paralyzed, ruined, and closed.

Meerschaum Pipes.

Meerschaum is the name of a kind of clay, and also of the smoking-pipe made from it. Like the French *écume de mer*, it conveys the same meaning as the Turkish or Tartar *keff-kil*—that of "sea-froth," or "sea-foam." The substance itself is a remarkable one. In a general sense, it may be regarded as a clay; but chemically it is a hydrated silicate of magnesia, beautifully white, if quite pure. This purity, however, can seldom be insured; silicates of iron and alumina are nearly always present, staining the substance with irregular shades of yellow and brown. Some specimens are heavy enough to sink in water, some light enough to float; medium densities are found to be best in quality. The fracture is earthy rather than conchoidal, and the softness such that cutting is easy. Deposits of this earth are met with in Moravia and Galicia, at Sebastopol and Kaffa in the Crimea, at a few spots in Hungary, Greece, and Spain, but more extensively in Asia Minor. In the last-named country it is found below the soil in the alluvial beds at Kittisch and Mursa, and in deeper deposits at Eski-Kissar. The name "sea-foam," or "sea-froth," was first given to it by uninformed observers, who, meeting with it occasionally in rounded snow-white lumps on the sea-shore, imagined it to be a product of the sea. The natives of South Russia use the crude earth as a detergent, somewhat in the same manner as pearlash, soda, or fullers' earth; but all except the very poorest varieties are reserved for pipe-making. In Asia Minor, Koniah is the head-quarters of the trade. The existence of real meerschaum is known by the whitish appearance which it gives to the surface of the ground. It lies in small detached beds, from ten to forty feet in thickness; or else in thinner layers, under a stratum of marl. When dug up it is as soft as cheese, and may be kept moist for several weeks or months if well covered.

In the days of Dr. E. D. Clarke the meerschaum trade was thus managed:—"The first rude form is given to the pipes upon the spot where the mineral is found. Here they are pressed within a mould, and laid in the sun to harden; afterwards they are baked in an oven, boiled in milk, and rubbed with soft leather. In this state they go to Constantinople, where there is a special bazaar or khan for them; they are then bought up by merchants, and sent by caravan to Pesth, in Hungary. Still the form of the pipe is large and rude. At Pesth, the manufacturers begin to fit them for the German market. They are soaked for twenty-four hours in water, and then turned in a lathe. In this process, many of them proving porous, are rejected; sometimes only two or three out of ten are deemed worthy of further labour. From Pesth they are conveyed to Vienna, and frequently mounted in silver. After this they are carried to the fairs of Leipsig, Frankfort, Mannheim, and other towns upon the Rhine, where the best sell for from three to five and even seven pounds sterling. When the oil of tobacco, after long smoking, has given them a fine porcelain yellow, or, which is more prized, a dark tortoise-shell hue, they have been known to sell for forty or fifty pounds of our money."

The trade arrangements have changed a good deal since Dr. Clarke's time, especially in regard to the high prices now willingly given for artistically carved heads, even without the claims of "porcelain yellow" or "dark tortoiseshell" hues. The rough fashioning of the bowl in Turkey is contrived for Turkish smokers; but the Germans import the earth itself in the form of irregular blocks or lumps. If cheap pipes are to be made, the makers are, of course, not very particular about quality; but for the better and more costly pipes, faulty particles have to be removed from the earth, hard stony bits (called by the Germans *kreidemassen*) rejected, ferruginous and aluminous silicates shunned. Before actually shaping the bowl the lump of mineral is steeped in wax, oils, and fats, the absorption of which gives to the pipe that "colouring" power which connoisseur smokers prize; a chemical action takes place between the hot tobacco, the oils and fats, and the silicates of the clay, tending to the production of a kind of tortoiseshell tinting. Sometimes a solution of copperas is used before the oils, to expedite the change of tint. The finest carved bowls (to be looked at rather than used) are maintained of the purest white.

The love of cheapness leads to unacknowledged manipulations in this trade as in others. Many clippings and parings, shavings and fragments, result from the working; and these waifs and strays are utilized in a way not always suspected by the purchaser of a meerschaum pipe. These are made into *massa-köpfe*, or *massa bowls*. The fragments are ground to a fine powder, boiled in water, and moulded in blocks large enough for one pipe-bowl each. If the maker adds common pipe-clay to the meerschaum earth he can sell his product at a lower price; and thus there are various degrees of sophistication in the meerschaum pipes displayed in the shop windows. Generally speaking, the composition is heavier than pure meerschaum; and this is the most usual test for distinguishing between them.

Indian and Persian Hookahs.

The *hookah* of India is the most splendid and glittering of all pipes; it is a large affair, on account of the arrangements for causing the smoke to pass through water before it reaches the lips of the smoker, as a means of rendering it cooler and less rank in flavour. On the top of an air-tight vessel, half filled with water, is a bowl containing tobacco; a small tube descends from the bowl into the water, and a flexible pipe, one end of which is between the lips of the smoker, is inserted at the other end into the vessel, above the level of the water. Such being the adjustment, the philosophy of the inhalation may be easily understood. The smoker sucks the air out of the vessel, and makes a partial vacuum; the external air, pressing on the burning tobacco, drives the smoke through the small tube into the water beneath; purified from some of its rank qualities, the smoke bubbles up into the vacant part of the vessel above the water, and passes through the flexible pipe to the smoker's mouth. Sometimes the affair is made still more luxurious by substituting rose-water for water *pur et simple*. The tube is so long and flexible, that the smoker may sit (or squat) at a small or a great distance from the vessel containing the water. In the courts of princes and wealthy natives the vessels and tubes are lavishly adorned with precious metals. One mode of showing hospitality in the East is to place a hookah in the centre of the apartment, range the guests around, and let all have a whiff of the pipe in turn; but in more luxurious establishments a separate hookah is placed before each guest.

Some of the Egyptians use a form of hookah called the *narghilé* or *nargeeleh;* so named because the water is contained in the shell of a cocoanut, of which the Arabic name is *nargeeleh*. Another kind, having a glass vessel, is called the *sheshee;* having, like the other, a very long tube. Only the choicest tobacco is used with the hookah and nargeeleh; it is grown in Persia. Before it is used, the tobacco is washed several times, and put damp into the pipe bowl; two or three pieces of live charcoal are put on the top. The moisture gives mildness to the tobacco, but renders inhalation so difficult that weak lungs are unfitted to bear it. The dry tobacco preferred by the Persians does not involve so much difficulty in "blowing a cloud."

Turkish Chibouques and Wood Pipes.

The stiff-stemmed Turkish pipes, quite different from the flexible tube of the hookah and *narghilé*, are of two kinds, the *kablioun* or long pipe, and the *chibouque* or short pipe. Some of the stems of the kablioun, made of cherry-tree, jasmine, wild plum, and ebony, are five feet in length, and are bored with a kind of gimlet. The workman, placing the gimlet above the long slender branchlet of wood, bores half the length, and then reverses the position to operate upon the other half. The wild cherry-tree wood, which is the most frequently employed, is seldom free from defects in the bark, and some skill is exercised in so repairing these defective places that the mending shall be invisible. The *tulés* or pipe-bowls used with these stems are mostly a combination of two substances, the red clay of Nish and the white earth of Rustchuck; they are graceful in form and sometimes decorated with gilding. It is characteristic of some of the Turks that they estimate the duration of a journey, and with it the distance travelled, by the number of pipes smoked, a particular size of pipe-bowl being understood. Mr. Dodwell, in his "Tour through Greece," says that a Turk is generally very clean in his smoking apparatus, having a small tin dish laid on the carpet of his apartment, on which the bowl of the pipe can rest, to prevent the tobacco from burning or soiling the carpet. The tubes of the kablioun are often as much as seven or eight feet long. Some of the gardens of Turkey and Greece contain jasmine trees purposely cultivated to produce straight stems for these pipes. Of those Turkish pipes which are used in Egypt, Mr. Lane, after mentioning the narghilé and the chibouque or "shibuk," says:—"The most common kind used in Egypt is made of wood called *garmashak* (I believe it is maple). The greater part of the stick, from the

mouthpiece to three-fourths of its length, is covered with silk, which is confined at each extremity by gold thread, often intertwined with coloured silks, or by a tube of gilt silver; and at the lower extremity of the covering is a tassel of silk. The covering was originally designed to be moistened with water, in order to cool the pipe, and consequently, the smoke, by evaporation; but this is only done when the pipe is old or not handsome. These stick pipes, are used by many persons, particularly in winter; in summer the smoke is not so cool from them as from the kind before mentioned. The bowl is of baked earth, coloured red or brown.

Austrian and Hungarian Pipe-Stems.

Before passing to the subject of the costly mouthpieces of Oriental pipes, we must say a few words concerning the extraordinary care bestowed on some kinds of plain wood sticks for stems or tubes.

Cherry-tree stems, under the name of *agriots*, constitute a specialty of Austrian manufacture. The fragrant cherry (*prunus makaleb*) is a native of that country; and the young trees are cultivated with special reference to this application. They are all raised from seed. The seedlings, when two years old, are planted in small pots, one in each; as they grow, every tendency to branching is checked by removing the bud; and as they increase in size from year to year, they are shifted into larger pots or into boxes. Great care is taken to turn them round daily, so that every part shall be equally exposed to sunshine. When the plants have attained a sufficient height they are allowed to form a small bushy head; but the daily care is continued until the stems grow to a proper thickness. They are then taken out of the ground, the roots and branches removed, and the stem bored through when seasoned for some time. The care shown in rearing insures perfect straightness of stem, and an equable diameter of about an inch or an inch and a-half. The best specimens, when cut from the tree, are as much as eight feet long, dark purple-brown in colour, and highly fragrant. At Pesth are made pipes about eighteen inches in length of the shoots of the mock orange (*Philadelphus coronarius*), remarkable for their quality of absorbing the oil of tobacco; they are flexible without being weak. The French make elegant pipe bowls of the root of the tree-heath (*Erica arborea*); but their chief attention is directed, so far as concerns wood pipes, to those of brier-root, which are made by them in large quantities. The bowl and the short stem are carved out of one piece, and the wood is credited with absorbing some of the rank oil of tobacco.

Amber Mouthpieces.

Amber—the only kind of resin that rises to the dignity of a gem—is unfitted for the bowl of a tobacco-pipe, because it cannot well bear the heat; but it is largely used for mouthpieces, especially by wealthy Oriental smokers. The Turks have a belief that amber wards off infection; an opinion which, whether right or wrong, tells well for the amber workers. There has always been a mystery connected with this remarkable substance. So far back as the time of the Phœnicians, amber was picked up on the Baltic shore of what is now called Prussia; and the same region has ever since been the chief storehouse for it. Tacitus was not far wrong when he conjectured that amber is a gum or resin exuded from certain trees; although other authorities have preferred a theory that it is a kind of wax or fat which has undergone slow petrifaction. At any rate, it must at one time have been liquid or semi-liquid; for insects, flies, detached wings and legs, and small fragments of various kinds, are often found embedded in it—those odds and ends of which Pope said:—

> "The things, we know, are neither rich nor rare;
> The wonder's how the devil they got there!"

Whether new stores of amber are now being formed, or whether, like coal, it was the result of causes not now in operation, is an unsolved problem. The specimens obtained differ considerably; some are pale as primrose, some deep orange or almost brown; some nearly as transparent as crystal, some nearly opaque. Large pieces, uniform in colour and translucency, fetch high prices; and there are fashions in this matter for which it is not easy to account, seeing that the Turks and other Orientals buy up, at prices which Europeans are unwilling to give, all the specimens presenting a straw-yellow colour and a sort of cloudy translucency. The Russians, on the contrary, prefer orange-yellow transparent specimens.

The amber is seldom obtained by actual mining. It is usually found on the sea-coasts after storms, in rounded nodules; or, if scarce on shore, it is sought for by men clad in leather garments, who wade up to their necks in the sea, and scrape the sea bottom with hooped nets attached to the end of long poles; or (rather dangerous work) men go out in boats, and examine the faces of precipitous cliffs, picking off, by means of iron hooks, the lumps of amber which they may see here and there. Sometimes a piece weighing nearly a pound is found, and a weight of even ten pounds is recorded. As small pieces can easily be joined by smoothing the surfaces, moistening them with linseed oil, and pressing them together over a charcoal fire, and as gum copal is sometimes very like amber, there is much sophistication indulged in, which none but an expert can guard against. In fashioning the nodules of amber, whether genuine or factitious, into pipe mouthpieces, they are split on a leaden plate in a turning lathe, smoothed into shape by whetstones, rubbed with chalk and water, and polished with a piece of flannel. It is a special kind of work; for unless the amber is allowed frequent intervals for cooling, it becomes electrically excited by the friction, and shivers into fragments; the men, too, are put into nervous tremors if kept too long at work at one time. Amber is one of the most electrically-excitable of all known substances; in fact, the name electricity itself was derived from *electron*, the Greek name for amber. Hookahs, chibouques, narghilés, meerschaums, all are largely adorned with amber mouthpieces. The mouthpiece often consists of two or three pieces of amber, interjoined with ornaments of gold and gems; it is in such case the most costly part of the pipe. At one of the greater industrial exhibitions four Turkish *amames*, or amber mouth-pieces, were shown, illustrating clearly enough the value attached to choice specimens; two of them were worth £350 each, two £200 each, diamond studded. The Turkish and Persian pipes have often a small wooden tube inside the amber mouthpiece. They require frequent cleaning with a long wire and a bit of tow; and in some large towns there are professional pipe cleaners.

Cigar and Cigarette Machines.

As a cigar is its own tobacco-pipe, a few words will suffice concerning its manufacture. Leaves of tobacco being spread out on a bench, the workman takes them up one by one, folds them, strips off the stalk by a quick and dextrous movement, throws the stalks on one side, and lays down the stripped leaves smoothly on the other. Another workman takes up one of the leaves, spreads it out flat, and cuts it to a form somewhat like that of one of the gores of a balloon; he lays a few small cuttings and fragments of tobacco on the leaf, and rolls them up into a form nearly resembling that of a cigar. Placed against a gauge or guide, this incipient cigar is cut to the proper length. Finally, a narrow strip of leaf is laid on the bench, and the workman rolls the cigar specially in it, twisting one end to prevent it from loosening. All this is done with wonderful celerity. We have spoken of *workmen;* but in practice many of the processes are conducted by women and young persons. Most of the cigar-making in London is carried on in the neighbourhood of Whitechapel and Shoreditch, in a densely populated district. The largest establishments employ two or three hundred hands each; from which maximum they descend to the humble scale of a dirty room in a dirty house, with a few workers huddled together in discomfort, with little light and less ventilation. (These last-named places are likely to feel the beneficial effects of the visits of inspectors, under the provisions of the lately passed "Workshops and Factories Acts.") Women and young persons are mostly employed in making up the *fillers* or fragments into a *bunch* or roll; but a more experienced hand is required to envelope the bunch in a *wrapper*, and then to coil it in a *cover*. It must needs be quick work, for only sixpence a hundred is paid for making the commonest cigars; from this minimum the payment rises to half-a-crown, according to size and quality: in these cases experienced men only are employed.

Ingenuity has not been wanting in the construction of cigar-making machines for expediting some of the processes. In De Bary's machine about 1,200 cigars can (it is asserted) be made in an hour, with a smaller quantity of outer leaf than is necessary in hand-making; it makes them either tight or loose, and of various shapes and sizes, by a few adjustments of the apparatus. There is also a machine by Scholfield; but we have no reason to believe that either of these mechanical contrivances has come much into use. Cigar-making in England is only watched by the Government so far as is necessary for the protection of the revenue—3*s.* 2*d.* per lb., seven times as much as the value of the cheapest tobacco for the cheapest cigars; but, in many foreign countries this branch of trade is altogether a State monopoly.

Cigarette-making is a much simpler process than that of cigars. The thin sheets of paper are cut into pieces of the proper size and shape; a few fragments of finely cut tobacco are dextrously coiled in each piece; sometimes an extra or outer tube is coiled round half the length, and a few touches at the end finish the cigarette. A clever cigarette-machine has been

invented by M. Adorno. An endless strip of paper enters the machine at one end, together with the requisite quantity of tobacco; and then, after going through fourteen successive operations, emerges at the other end of the machine in the form of a finished cigarette. M. Susini has introduced another machine for the same purpose. The paper, cut to the proper form, is lifted by means of a vacuum produced by an air-pump, and presented to the side of a cylinder, which rolls it, and at the same time tips the end with glue to fasten it; a second operation folds and closes one end of the paper tube thus made. The tube is removed to a kind of hopper filled with tobacco, which is forced into it by a small piston. With such celerity do these movements succeed each other, that the machine is said to make thirty cigarettes per minute, or 18,000 in a day of ten hours. Skilful hand-workers at Havana can make 2,000 to 3,000 cigarettes per day.

Pipes at the International Exhibition.

It may be doubted whether there was ever before so fine a display of smoking pipes as that which is made at the London International Exhibition this year. The South Kensington Museum contains some remarkable specimens, many of which have been lent to the Exhibition for the present purpose; but there has not until now been so varied and extensive a collection. The Indian department, as has been the case at all the principal industrial exhibitions for years past, makes a glittering show of those magnificent hookahs in which that country takes the lead; gold and silver filagree, pearl and ivory, ebony and sandalwood, jade and agate, silken threads and embroidered tissues, form the decorations appended to the more substantial vessels—bowls and elastic tubes—themselves made of costly materials. Last year, when H.R.H. the Duke of Edinburgh arranged his admirable Loan Collection at South Kensington Museum, comprising works of curiosity and of art which had been purchased by or presented to him during his prolonged tour in the East, he included a gorgeous hookah, given to him by one of the native princes of India. Many visitors marvelled how so much costly magnificence could be bestowed on a mere smoking pipe; but the present Exhibition shows that such luxuries are well known at the courts of rajahs, nabobs, pachas, and in the palaces of the lesser notables. There is a part of a hookah taken at Seringapatam, and supposed to have belonged to the famous Tippoo Saib; and amongst other specimens are hookahs from India and Persia, noticeable for the great length of the flexible tube, affording to the smoker much liberty of choice as to the distance at which he will sit from the tobacco bowl and water vessel of his pipe. In connection with the manufactures of the present day, it may be interesting to note that the Wedgwoods and Copelands have exercised their skill in the production of hookah vessels in porcelain and stoneware, displaying considerable artistic taste, without the metallic glitter of the Oriental productions.

The meerschaum pipes are varied, curious, and some of them very costly. One, the bowl surrounded with an elaborately carved group of figures, is priced at no less than 155 guineas. Of course no one would think of smoking such a pipe, except for the name of the thing: it would be more trouble than pleasure for general use. Another displays an ambitious attempt to represent the Light Cavalry charge at Balaklava; the troopers are not very good representatives of English Hussars and Lancers, and it is not quite clear which side is getting the worst of it; but much ingenuity is certainly displayed in carving the meerschaum clay into such forms. The way in which some of the bowls are tortured into representations of the heads and bodies of animals, or of human beings in contorted positions, is more curious than beautiful; while in other cases a few touches by the knife or chisel of the carver have sufficed to produce a really graceful and artistic design.

Among the curiosities, the odd pipes belonging to miscellaneous groupings, a foremost place must be given to some old English clay pipes that bear off the palm against any now made. The stems, six, eight, or even twelve feet in length, are convoluted into the most fanciful forms—spirals, circles, wheels, syphon bends, French horn twists, serpentine double curves, &c.; the tube of each pipe is preserved perforate throughout, and the outsides are adorned much in the same style as the old china and earthenware of a century or so back. As the visitor to the Exhibition passes along from one loan collection of pipes to another, he will find many specimens that will interest him, and possibly not a few that will amuse him—such as a carved horse of hard wood, with his head so hinged that tobacco may be put into his body; Death's head to constitute some bowls, and Punch's head others; cork bowls with goose-bone stems; most curiously twisted stems of German and Venetian glass; meerschaum stems that unscrew into several pieces, the worm of the screw being as neatly cut as if the substance were ivory; a Canton pipe for smoking plugs of tobacco through water; brier-root pipes, from eighteenpence to fifty shillings each; plain meerschaums from six shillings to twelve guineas; carved meerschaums from forty shillings to five times as many guineas; a Hindoo "hubble-bubble" pipe from Chinsura, apparently for enabling the smoke to bubble up through water; amber mouthpieces of curious form, and, no doubt, considerable value; "patent constitutional tobacco pipes," in meerschaum, and in wood lined with meerschaum, "with inner bowl to prevent the nicotine from coming to the mouth;" and a queer medley of little old dirty clay pipes, which some antiquarian has dug up in a field or a river, and which he regards as relics of generations long gone by.

It is not without interest to watch the labours of the makers of meerschaum pipes, clay pipes, and brier pipes, at the Exhibition, plying their skill in presence of the visitors, each with the veritable tubes and appliances of his trade.

THE GROWTH OF SOME GREAT PRACTICAL IDEAS.

IN an interesting appendix to their First Annual Report, the Directors of the "Positive Government Security Life Assurance Company" have drawn together some memoranda concerning the great improvements of modern times, particularly as regards the prejudice and opposition which they at first encountered. Their object in doing so is to encourage the supporters of the "Positive" in their efforts to popularize the distinctive character of that office. It is not, they assert, "an imitative institution, established for the purpose of adding one more life office to those previously existing, but it is, to all intents and purposes, the first of its kind, and gives a new and improved character to practical life assurance and its administration." The greater part of the appendix we transfer to our pages; it bears evidence of careful compilation, and is worth preservation as a curious and suggestive retrospect:—

We look around us, and in practical life, as well as scientific annals, perceive that numerous useful objects have been attained, and designs accomplished which not only the ignorant and prejudiced, but even wise and disinterested persons have pronounced to be either impossible of execution or baneful to the public weal if accomplished.

Let us glance at a few of these.

In physiology how many ages elapsed before the true doctrine of the circulation of the blood was expounded to the world? It was not until the year 1628 that Dr. William Harvey published the account of his immortal discovery. And how was it received by the learned physicians of his time? This greatest and most original discovery in physiology that had ever been made was scouted by them, and its author loaded with calumny and vituperation. He himself foresaw that this would be the case, and in the preface to his memorable work stated that he regarded it as only a necessary consequence of his setting forth a theory so adverse to all preconceived opinions. He feared that it would not only rouse the enmity of his professional brethren, but through that make all mankind his foes—so much are people wedded to the traditions of antiquity. There was some exaggeration in this, but in point of fact his practice fell off considerably immediately after the publication of his treatise. There was not a physician above forty years of age that recognized the truth of his doctrine, and it was bitterly and violently opposed both in writing and speech by the leading physiologists of his time at home and abroad. He had the good fortune, however, to outlive all this, and to see his theory finally accepted by the entire world.

Similarly, the now famous Dr. Jenner, the discoverer of vaccination as a prophylactic against the small-pox, was only ridiculed and calumniated when he first propounded his theory. He communicated it to Hunter, to Cline, and other well-known heads of the medical faculty, but from none of them did he receive assistance or encouragement. Even upon the publication of his work, in which convincing evidence as to the truth of his theory was set forth, there were those in the profession who gave it their most strenuous opposition. In about a year afterwards seventy of the principal physicians and surgeons in London declared their perfect confidence in the practice recommended. But when at length the benefit of vaccination came to be generally recognized, it was sought to deprive Jenner of the honour rightly due to him by affirming that he was not the original discoverer.

It is right and proper, indeed it is an imperative duty upon the medical profession, to hedge in the practice of medicine, and thus

guard the public from the nostrums of ignorant quacks; but how many valuable medicines do we now find universally adopted by them, and regularly incorporated in the Pharmacopœia against which, when they were originally propounded, the doctors cried out as being only useless and dangerous innovations? To take only one instance, the introduction of Jesuits' bark as a remedy in fevers. When the wonderful properties of this medicine were first made known to the world, it was generally decried by the members of the healing art. "Thus we learn," says Dr. Paris, "that Oliver Cromwell fell a victim to an intermittent fever, because the physicians were too timid to make a trial of the bark." For this he gives old Dr. Morton as his authority. Even so late as the end of Charles the Second's reign, Evelyn, who in 1685 saw growing in the gardens at Chelsea "the tree bearing Jesuits' bark which had done so much wonder in quartan agues," informs us in his "Diary," that the physicians would not give the king *quinquina*, "out of envy because it had been brought into vogue by Mr. Tudor, an apothecary!" Such examples tend to show that there are occasions when scepticism becomes folly, and prejudice almost a crime. Happily, in our days, we find the leading members of the medical profession adopting what is true, regardless of its being new, or from whatever quarter it may come, and thus vindicating their claim to be regarded as true philosophers.

Again, in natural science what wonderful discoveries were those of Galileo and Newton, and how slow was the world to receive them! The first-named of these two philosophers, indeed, was absolutely persecuted and brought on his knees before the Inquisition—it is doubtful even whether he was not subjected to the torture—at the age of seventy, for demonstrating the true theory of the solar system.

Newton was not so unfortunate, at least in his own country; where, contrary to the proverb, his fame was recognized; but it is stated that when he died it is probable he had not twenty disciples out of England; and it needed the pen of a Voltaire to make his merits known generally in the world.

If from pure science we turn to works of great public utility—engineering, architectural, and manufacturing enterprise—we call up the names of Sir Hugh Middleton, Sir Christopher Wren, the Duke of Bridgwater, Brindley, Telford, Sir Richard Arkwright, and others. It was in spite of the most strenuous opposition that these distinguished men brought their enterprises to a successful issue.

Middleton, after spending his entire fortune in his undertaking to supply London with water by means of his New River, applied to the Corporation for assistance, but was refused it. Fortunately King James, wiser in this instance than in numerous others, came to his aid, and enabled him to carry out his splendid project.

Sir Christopher Wren was thwarted in numerous ways in his endeavours to make London the pattern city of the world, after the disastrous fire of 1666.

It was with the utmost difficulty that the Duke of Bridgwater obtained an Act of Parliament to enable him to construct his first navigable canal, the precursor of that noble system of inland navigation which, with the aid of Brindley, he was enabled to carry out, both to his own enrichment and the benefit of his country. The Duke's first project was principally opposed on the ground that it would do away with the necessity of using manual labour. And when eventually the act was obtained, it was saddled with the condition that he was to use no horses or asses in the traffic. To obviate this hard condition, the Duke, it appears, took into his service a number of mules. And of Brindley it is related, that upon an examination before a Committee of the House of Commons, he was asked: "Of what use, then, are rivers?" And he replied, "To feed navigable canals!" So thoroughly was he wedded, heart and soul, to his one absorbing pursuit, the great object of his existence.

Exception has been taken to Arkwright, and much odium has been cast upon him, on the supposition that he appropriated to himself the discoveries of others, but of this the evidence is very defective, and the glory still remains to him of having been the founder of the cotton manufacture of Great Britain—the staple commodity of our country. He experienced every kind of discouragement. The manufacturers of Lancashire united in a league against him. The operatives burnt his mills, and the courts of law decided against the validity of his patents. Even his wife, according to some accounts, gave him every discouragement in his proceedings, saying "that he would starve his family by scheming when he should have been shaving." She even broke some of his experimental models, which so exasperated him that he at last separated from her, allowing her a small stipend for alimony.

A similar opposition was shown to the spinning-jenny invented by Hargreaves, a Lancashire weaver, in 1767. This was contrived at first to turn only light spindles, which were made to revolve by means of bands from a horizontal wheel. By degrees it was improved so much that as many as eighty spindles were worked by the new invention. This success roused the enmity of the numerous spinners in Lancashire—who followed the old method—to such an extent that a determined party among them rushed into Hargreaves' premises, destroyed his machines, and even threatened his life. The advantage of the invention, however, was so great, that it was again brought into use, when another rising of the operatives took place, and parties of exasperated weavers went up and down the country, destroying both spinning-jennies and carding machines wherever they could find them. The consequence was that the manufacture was for a time discontinued in Lancashire, and transferred to Nottingham.

The invention of the power-loom in weaving was the next great step towards the perfecting of the cotton manufacture of Great Britain. The inventor of this wonderful machine, Dr. Edmund Cartwright, a clergyman of the Church of England and a literary man, author of a few poems and essays, had never turned his attention towards machinery and manufactures, until he happened one summer day in 1784, on a visit to Matlock, to find himself in the company of some gentlemen from Manchester, when the discourse fell upon the mechanical operations of spinning and weaving. Struck with the importance of the subject mentioned, although in his fortieth year, he employed the natural energies of his mind in contriving a power-loom which should do for weaving what had already been done for spinning. By the following April he had succeeded in producing a machine, rude indeed, but subsequently receiving much improvement, which he patented. When brought into operation, such were the prejudices and envy of the neighbouring manufacturers, and such the ignorance of the operatives, that an establishment in which 500 of the new looms were employed was wilfully burnt down. Commercially Cartwright realized nothing by his invention; in fact he lost by it, and would have died a poor man, only that Parliament in 1809 awarded him the sum of £10,000 for "the good service he had rendered the public by his invention of weaving." Compare this with the £500,000 left behind him by Sir Richard Arkwright—but then Arkwright, originally only a barber, was gifted, not only with inventive powers, but with a genius for commercial speculation.

Jacquard, the famous silk-weaver of Lyons, and the inventor of the well-known "Jacquard-loom," was not better treated by the operatives of Lyons than was Cartwright by those of Lancashire. About the year 1790 he conceived the idea of an apparatus for figured weaving, and in 1801 he sent a model of it to the National Exposition of the Products of Industry, for which he obtained a bronze medal. In the same year he obtained a patent for his machine, and set up a loom at Lyons on the new principle, which was visited by Carnot and other statesmen in 1802. He was also the inventor of a machine-made net, which came into the hands of the Préfet at Lyons, and this functionary, for what reason does not appear, placed Jacquard under arrest, and sent both him and the machine to Paris. Here his invention was laid before inspectors, who approved of it and rewarded him with a gold medal. On this occasion he was introduced to Napoleon and Carnot, the latter of whom asked him whether he was not the man who proposed to tie a knot in a stretched string. Jacquard said yes, and succeeded in convincing the minister that such a thing was by no means an impossibility. After this he returned to his native city, where he sought to introduce his loom among the weavers, but his progress in this respect was very slow. The operatives had from the very commencement conceived a violent prejudice against both the machine and its author. They conspired to prevent its use at all as much as possible, and where it was introduced they purposely spoiled their work in order to bring it into discredit. Frequently, too, Jacquard was in personal danger from their animosity. Even the "Conseil des Prudhommes" of Lyons conspired with the operatives to ruin him, and actually ordered his machines to be broken up and sold as marine stores. "The iron," says Jacquard, speaking of the insult offered to him, "was sold for iron, the wood for wood; and I, the inventor, was delivered up to public ignominy." Eventually, however, his invention was brought into use, not only in France, but in Switzerland, Germany, Italy, and America. He lived to a great age, was presented with the Cross of the Legion of Honour, and in 1840 had a statue erected to his memory in the same city which had formerly treated him with so much ingratitude.

To the water-power and horse-power employed by Arkwright and others of his time, succeeded the far more efficacious agency of steam, thus described by Professor George Wilson:—"Take, for example, a cotton-mill. On the basement story revolves an immense steam-engine, unresting and unhasting as a star in its stately, orderly movements. It stretches its strong arms in every direction throughout the building; and into whatever

chamber you enter, as you climb stair after stair, you find its million hands in motion, and its fingers, which are skilful as they are nimble, busy at work. They pick cotton and cleanse it, card it, rove it, twist it, spin it, dye it, and weave it. They will work any pattern you select and in as many colours as you choose; and do all with celerity, dexterity, unexhausted energy and skill."

Nor is it in the cotton manufacture alone, but in almost every branch of industry besides, that the giant force of steam has wrought such wonders. Could James Watt, when he produced his first steam-engine, have foreseen the wondrous and beneficent results of his invention, he might almost have been tempted to look upon himself as a second Prometheus. But neither he nor any of his contemporaries ever dreamt what might possibly be the splendid consequences.

Among these were steam navigation and locomotives on railways.

Let any one consider, if he can, what would be the condition of the world at present without these two great agents of progress and civilization, and he will bow down with reverence before the genius and enterprise of their inventors and promoters. Think of a voyage from Liverpool to New York across the stormy Atlantic performed in eight days; of a journey by rail to Brighton in one hour, and to Edinburgh in ten hours; and compare these with the rate of progression achieved by the old sailing packets and the old stage-coaches. It is little more than a hundred years since it used to be advertized in the "Edinburgh Courant" that a coach would run between Edinburgh and London, taking ten days to do the journey in summer, and twelve in winter. In 1766 Lord Eldon, coming from Newcastle to London, travelled in a coach which for its quickness was called a "Fly;" still he was three or four days or nights on the road. In 1754 a "Flying Coach" ran between Manchester and London, in advertizing which it was stated, "However incredible it may appear, this coach will actually (barring accidents) arrive in London in four days and a-half!" Here is an advertisement respecting another coach, copied in full from "Lloyd's Evening Post," Nov. 28-30, 1763:—

"Brecknock and Monmouth Stage-Coach, in Four Days."—"Began going from the 'Bolt-and-Tun' in Fleet Street, London, on Wednesday, the 2nd of November, 1763, at Four o'clock in the Morning; lies the first Night at Oxford, the second at Glocester, the third at Monmouth, and arrives at the 'Golden Lion' at Brecknock on Saturday Evening, from whence it returns every Monday Morning at five o'clock, keeping the same stage as above, and gets to London on Thursday Evening. Each Inside Passenger from London to Brecknock, to pay £2 2*s.*; to Monmouth, £1 11*s.* 6*d.*, and to Gloucester, £1 3*s.*, and to be allowed 14 lb. weight Luggage, all above to pay 2½*d.* per Pound from Brecknock, and 2*d.* from Monmouth. Outside Passengers and Children in Lap, to pay Halfprice, and be allowed no Luggage.

"Performed by { W. TURNER, Wycomb. / J. TURNER, Glocester. / GILES GREENWAY, Ditto. / T. LONGFELLOW, Brecknock.

"The proprietors will carry no game, unless duly authorized from a qualified Gentleman, whose Name, together with the Day of the Month and Date of the Year, must be expressed on the Directions; each Hare to pay 1*s.* 6*d.* A Brace of Birds or a Couple of Cocks, 1*s.* A Goose 1*s.* 6*d.* A Turkey and Chine to pay by Weight. All Parcels under 10 lb. to pay 2*s.* All above, with other heavy Goods, to pay 2½*d.* a pound from Brecknock, and 2*d.* from Monmouth. The Carriage of Goods and Parcels to be paid on bringing to the Coach, and none of Value to be accounted for unless entered as such, and paid for accordingly."

Even in the best days of stage-coaching the "Quicksilver," between Bristol and London, took seventeen hours to perform a journey that can now be done in little more than two.

It was not, however, without much opposition and ridicule that these results have been achieved. Five miles an hour was thought at first to be the utmost speed allowable with safety on a railway, whereas we can now easily go fifty. In 1814 Stephenson's "Killingworth" engine travelled only at the rate of four miles an hour; and in 1825, Mr. Nicholas Wood, in his work on railways, calculated the utmost speed at six miles an hour, drawing forty tons on level ground. "Nothing," he says, "could do more harm towards the adoption of railways than the promulgation of such nonsense as that we shall see locomotive engines travelling at the rate of 12, 16, 18, and 20 miles an hour."

The "Quarterly Review" for March, 1825, took up the parable, saying:—"As to those persons who speculate on making railways general throughout the kingdom, and superseding all the canals, all the waggons, mail and stage coaches, post-chaises, and, in short, every other mode of conveyance by land and by water, we deem them and their visionary schemes unworthy of notice. Every particular project must stand or fall by its own merits; and we are greatly mistaken if many of those which are already announced will not, when weighed, be found wanting. The gross exaggerations of the powers of the locomotive steam-engine, or, to speak in plain English, the *steam-carriage*, may delude for a time, but must end in the mortification of those concerned." It then goes on to ridicule a project for a railroad between London and Woolwich which had received the support of so eminent an engineer as Telford; and continues—"In a similar strain we find a countryman of Mr. Telford writing thus—'We shall be carried at the rate of four hundred miles a day, with all the ease we now enjoy in a steam-boat, but without the annoyance of sea-sickness or the danger of being burned or drowned.' It is certainly some consolation to those who are to be whirled at the rate of eighteen or twenty miles an hour, by means of a high-pressure engine, to be told that they are in no danger of being sea-sick while on shore; that they are not to be scalded to death, nor drowned by the bursting of the boiler; and that they need not mind being shot by the scattered fragments, or dashed in pieces by the flying off or the breaking of a wheel. But with all these assurances, we should as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's *ricochet* rockets as trust themselves to the mercy of such a machine going at such a rate. Their property, perhaps, they may trust; but while one of the finest navigable rivers in the world runs parallel to the proposed railroad, we consider the other 20 per cent. which the subscribers are to receive for the conveyance of heavy goods almost as problematical as that to be derived from the passengers. We will back Old Father Thames against the Woolwich Railway for any sum."

Even Watt himself originally planned his locomotives merely for use on country roads with ordinary speed; and when his assistant, William Murdoch, was occupying himself with planning an engine to run on a tramway, he thought it a waste of time, and requested his partner Boulton to tell Murdoch that this was his opinion.

When Stephenson was engaged in planning the railway from Manchester to Liverpool, there was some difficulty anticipated in laying the rails across Chat Moss. An eminent opposing engineer said, "No man in his senses would attempt a railway over Chat Moss." At all events, if carried out, that it would involve a fabulous expenditure of money. Stephenson, however, did it, and at an expense of only £28,000. "But, Lord, to think!" as old Pepys might say, how lightly do our modern engineers regard such obstacles!

When it became known that the bill for the Liverpool and Manchester Railway would be proceeded with in 1825, a strong opposition was immediately organized against it. Mr. Smiles informs us that "the canal companies prepared to resist the measure tooth and nail." "The public were appealed to on the subject; pamphlets were written and newspapers were hired to revile the railway. It was declared that its formation would prevent cows grazing and hens laying, The poisoned air from the locomotives would kill birds as they flew over them, and render the preservation of pheasants and foxes no longer possible. Householders adjoining the line were told that their houses would be burnt up by the fire thrown from the engine-chimneys; while the air around would be polluted by clouds of smoke. There would no longer be any use for horses; and if railways extended, the species would become extinguished, and oats and hay be rendered unsaleable commodities. Travelling by rail would be highly dangerous, and country inns would be ruined, boilers would burst, and blow passengers to atoms. But there was always this consolation to wind up with—that the weight of the locomotive would completely prevent its moving, and that railways, even if made, could *never* be worked by steam-power. Nevertheless, the canal companies of Leeds, Liverpool, and Birmingham called upon every navigation company in the kingdom to oppose railways wherever they were projected, but more especially the Liverpool and Manchester scheme, the battle with which they evidently regarded as their Armageddon. A Birmingham journal invited a combined opposition to the measure, and a public subscription was entered into for the purpose of making it effective. The newspapers generally spoke of the project as a mere speculation; some wishing it success, although greatly doubting; others ridiculing it as a delusion, similar to the many other absurd projects of that madly-speculative period. It was a time when balloon companies proposed to work passenger traffic through the air at forty miles an hour, and when coaching companies projected carriages to run on turnpikes at twelve miles an hour, with relays of bottled gas instead of horses. There were companies for the working of American gold and silver mines, companies for cutting ship canals through Panama and Nicaragua, milk

companies, burying companies, fish companies, and steam companies of all sorts; and many less speculatively disposed than their neighbours were ready to set down the projected railways of 1825 as mere bubbles of a similarly delusive character." In truth, by no means a favourable time for Stephenson and his projected railway!

In March, 1825, the bill for the Manchester and Liverpool Railway was referred to a select committee of the House of Commons, when George Stephenson was under cross-examination for three entire days. Mr. Alderson, afterwards Baron Alderson, the principal counsel against the bill, spoke for three whole days against it. At the conclusion of his speech, he summed up by pronouncing Mr. Stephenson's plan to be "the most absurd scheme that ever entered into the head of man to conceive. My learned friends," said he, "almost endeavoured to stop my examination. They wished me to put in the plan, but I had rather have the exhibition of Mr. Stephenson in that box. I say he never had a plan; I believe he never had one—I do not believe he is capable of making one. His is a mind perpetually fluctuating between opposite difficulties. He neither knows whether he is to make bridges over roads or rivers of one size or another, or to make embankments or cuttings or inclined planes, or in what way the thing is to be carried into effect. Whenever a difficulty is pressed, as in the case of a tunnel, he gets out of it at one end, and when you try to catch him at that, he gets out at the other."

The bill was lost upon this occasion, but was subsequently carried, and this first railway was thrown open to the public on the 15th September, 1830, George Stephenson having organized the whole work himself, without the aid of contractors or navvies.

Notwithstanding this success, the opposition to railways continued as strong as ever in various quarters. Colonel Sibthorp openly declared his hatred of the "infernal railroads," and said he "would rather meet a highwayman or see a burglar on his premises than an engineer." Mr. Berkeley, the member for Cheltenham, "wished that the concoctors of every such scheme, with their solicitors and engineers, were at rest in Paradise."

To discuss here the vexed question as to the *invention* of steam navigation would carry us far beyond our limits. Whether it was originally due to the Marquis of Worcester, and first laid before the world in the sixty-eighth of his "Century of Inventions," we shall not pause to consider: all that we are concerned to show is—the immense difficulties against which steam navigation had to contend when first brought into practical operation.

William Symington may be regarded as the first contriver of a practical steamboat. In 1787, in conjunction with Messrs. Miller and Taylor, he launched a small boat on the lake at Dalswinton propelled by a steam-engine and paddle-wheels; and in 1801, under the auspices of Lord Dundas, he produced the first practical steamer, named the "Charlotte Dundas," to run on the Forth and Clyde Canal. This fully answered the expectations of both Symington and Lord Dundas, but the directors of the canal declined to adopt it from a belief that the force of the wave would damage the canal banks. Fulton, an American, made himself acquainted with the experiments carried on at Dalswinton, and endeavoured to introduce steam navigation into France. In this he was unsuccessful, although the Emperor Napoleon was much taken with it, and in 1804 declared it to be a scheme capable of changing the face of the world. Fulton carried his energy with him to the United States, where, in 1807, he launched his first steamboat on the Hudson, and between that time and 1812 there were steamers on all the great rivers in America. In 1812 the "Comet," built by Henry Bell, was launched on the Clyde. In 1811 a Mr. Dyer sought to introduce steam navigation on the Thames, but was thwarted in his endeavours. Even experienced engineers like Rennie and Ewart advised him to relinquish his projects, as one that would prove both expensive and impracticable. It was not until 1814 that a steamer was launched on the Thames by Mr. George Dodd. This ran between London and Richmond, and was, of course, assailed with abuse and opposition by the Thames watermen. The same was the case with the steamers running between London and Gravesend. In 1814 Sir Isambard Brunel made a voyage to Margate in a steamboat of his own, propelled by a double-acting engine; and upon landing he was received with abuse and insult by the bystanders. Even the landlord of the hotel at which he put up refused to accommodate him with a bed! In 1836 he went to the same hotel, the "York," when he was engaged in advising the survey for the proposed railway to Ramsgate. Writing to a friend, he remarked upon what had happened to him on his former visit, adding:—"If they knew at this moment that I came to carry off the cargoes of the steamers to Ramsgate, I might probably share the same fate!"

The "Savannah" was the first steam-vessel that made a considerable sea voyage—namely, from New York to Liverpool—which she did in twenty-six days; but in this voyage steam was not used during the entire distance. Henceforward steam was employed extensively in short sea voyages; but it was not until 1838 that the first large steamers were constructed to ply between England and America. These were the "Sirius" and the "Great Western," which sailed from Bristol, and performed the voyage to New York in perfect security. The "President," which sailed from New York in 1841, having on board the inimitable John Power, was unfortunately lost, leaving no trace of her, so far as is known, in the wide world.

We need scarcely say that steam navigation, both for long and short voyages, so much decried and opposed in its infancy, is now in general use among civilized nations.

Leaving steam navigation and railways, let us for a moment consider how often it has been sought to stem the tide of social improvement, even by legislative enactments.

The cotton-trade in its infancy had much to contend against from the *wisdom* of our ancestors, who were fearful that it might interfere with the wool staple of old England.

In Henry the Eighth's time there was a legislative prohibition against the use of coals in London as household fuel. In Elizabeth's there was an enactment against the extension of London by the building of more houses in a westerly direction; and hear it, oh lovers of bitter ale! it is in record that early in the seventeenth century the Corporation of the City of London petitioned against the use of hops in the brewing of beer—"in regard they would spoil the taste of drink, and endanger the people!"

Some of the greatest schemes for the benefit of mankind have been opposed on political grounds: as, for instance, that of the famous ship-canal through the Isthmus of Suez. This project, when first propounded by M. de Lesseps, was bitterly opposed by no less a statesman than Lord Palmerston, who to the end of his life contended against it. Engineers of the highest eminence also pronounced against it. They represented that the levels of the Mediterranean and Red Seas were so different, that it would be impossible to prevent an impetuous current flowing through the canal; likewise that the shifting sands along its sides would overwhelm the work; and that the silt on the northern shore would choke up the mouth at Port Saïd. Even Robert Stephenson, who was sent over expressly by Lord Palmerston to report on the scheme, denounced it as one that was utterly impracticable. In spite of such formidable opposition, however, M. de Lesseps continued his operations; and, with the warm support of the Empress Eugénie, these were at length brought to a successful issue.

When the result came to be foreseen as morally certain, Lord Palmerston declared in the House of Commons that the opening of the Suez Canal must give a vast advantage to France as compared with this country, by enabling her fleets to pass through it from Toulon into the Indian Seas long before ours could find their way there.

We now smile at the apprehensions of the aged minister—apprehensions that were shared by numerous persons in this country—but we should recollect that, when Lord Palmerston gave utterance to them, Napoleon III. was in the plenitude of his power, long before the disasters and humiliation which France had to sustain through her war with Germany.

This gigantic undertaking, first conceived in 1854, the works being commenced in 1859, was finished in December, 1869, when the Suez Canal was thrown open to the commerce of the world. For his energy and skill, and, above all, for the success that crowned his efforts, M. de Lesseps received numerous honours, including the freedom of the City of London, and the decoration of Grand Commander of the Star of India from Queen Victoria.

As England, however, from motives of national jealousy, opposed the construction of the Suez Canal, so did France, from similar motives and at about the same time, oppose the construction of the great Mont Cénis Railway. Mont Cénis traverses the Western Alps, between Savoy and Piedmont, a distance of seven and a-half miles, and a scheme was brought forward to tunnel through the entire distance, thus connecting the railway systems of France and Italy. This great undertaking was originally commenced in 1857 by the Sardinian Government, but with inadequate means. When Savoy became incorporated with France, in 1860, the Government of Napoleon III. offered to contribute towards the expense of its construction, bargaining that its subsidy should be in proportion to the energy with which the work was carried on. After the unification of Italy, however, in 1866, France reconsidered the subject of the Mont Cénis Railway, and threw every obstacle in the way of its completion, fearing that the continued line to the East by way of Brindisi might interfere with her own route by way of Marseilles. For five years this opposition went on, but the

Italian engineers continued their work; and the great Mont Cénis Railway Tunnel, one of the greatest triumphs of engineering skill that ever the world has seen, was completed on the 17th of September, 1871.

In a commercial country like ours it may fairly be a matter of astonishment how business could have been carried on for so many hundred years without such an institution as the Bank of England. Still more surprising must it now seem to us, that when at length an enlightened and enterprising man stepped forward to inform the English public of the immense want under which they were labouring, and of his readiness to supply it by the establishment of a great public bank, resting upon a basis of perfect security, his representation and proposal should have been canvassed in a perfectly hostile manner by a considerable number of persons throughout the country. And yet this was the case with William Paterson and his project for establishing a Bank of England.

The germ of Paterson's proposal was contained in a suggestion made by him to a Committee of the House of Commons, in 1691, on the collection and management of the public loans. His opinion was, "That in lieu of occasional and unsettled loans formerly made to Government, a fixed sum of £1,000,000 should be advanced by the trading merchants, at six per cent. interest, as a perpetual fund to be managed by trustees chosen from the subscribers, and used not only in supplying the pressing claims of Government, but also in forming a public bank, to exchange such current bills as should be brought to be enlarged, the better to give credit thereunto, and make the said bills the better to circulate."

Paterson was well known to many of the most distinguished London merchants, by whom his opinions in commercial affairs were held in high respect, and when he afterwards set forth his proposal in set terms for the institution of a National Bank, it received their favourable consideration and support. Foremost among these was Michael Godfrey, a City merchant, who strongly advocated his views in commercial circles. while Montague, Earl of Halifax, gave him his support in Parliament and at Court. There was a Mr. Lowndes, however, Secretary to the Treasury, who opposed him with many specious arguments, and he enlisted numerous other persons who shared his views in favour of things as they were.

The principal objections made to a National Bank were noticed by Paterson himself in a remarkable pamphlet published in 1694, under the title of "A Brief Account of the Intended Bank of England." In this pamphlet, after enlarging upon the necessity for such an institution, he writes:—"These, and such as these, were the causes that the nature and use of banks and public funds have been the discourse and expectation of many years. But all this while our refined politicians assure us that we must never think of settling banks in England without a commonwealth; and this notion became so universal, that it was matter of derision for any one to seem to be of a contrary opinion. Thus the modish vein of farce and ridicule, so prevalent over the morality, virtue, and reason of our times, had like to have deprived us of them." What an extraordinary notion was this, that a National Bank could exist only under a Commonwealth!

The writer goes on thus:—"But the notion of banks and public funds was entertained by some mercurial heads, who, finding the main objection against them in England to be the danger of violence from the prince, invented several imaginary banks and funds, which they designed to settle far enough from the prince's reach, or anybody else's."

The first design of this nature was to turn a Lombard into a bank, and to that end they cried down the use of gold and silver, and up that of other materials in lieu thereof. But when they found the world very unwilling to leave their old way without better reason, or something more enticing, they ran from their new mistake to an old one, which was, that the stamp or denomination gives or adds to the value of money. . . Thus, between the new acquired maxims of our modern politicians on the one hand, and the incomprehensible notions conceived on the other, it became very scandalous to countenance or espouse anything of a proposal relating to a bank.

Thus, as we perceive, the opponents of the bank were not all of one way of thinking. "As the proposers found great discouragement from one sort of men, who could by no means reconcile this proposal with their own apprehensions and the old Norman way of borrowing money, so others seemed to understand it too much, and would only have it proposed at 4 or 4½ per cent., whereof 3 per cent. to be allowed to be paid, and the remainder for those who should forward money to circulate the same; for otherwise, say they, it will clean discourage land, as everybody will be for disposing their money upon so convenient, clear, and secure an interest, rather than expect something more with trouble and uncertainties."

It may be worth while, and at least will be amusing, to quote still further from Paterson's pamphlet:—

"One pretended patriot," he says, "comes and tells us, this design will make the king absolute, by becoming master thereof, nor is there any way to prevent it; 'for,' says he, 'rich and monied men, we find by experience, are naturally timorous and fearful, and are easily brought to comply with the times to save what they have. And the keeping of this fund being of necessity committed to such, the prospect of their profit, in conjunction with their natural easiness, will of course induce them to join with the prince who is always best able to encourage and support them.' Another comes, with a boast, and tells ye, 'that he or his grandsire, uncle, or some of the race, have been abroad in some country or other, and in all their peregrinations they never met with banks nor stocks anywhere, but only in Republics; and if we let them get footing in England, we shall certainly be in danger of a Commonwealth.' . . . . Some, who pretend to see further into a millstone than others, will undertake to make it plain that it will raise and enhance the price of land, and utterly discourage and ruin trade; for by this means, say they, all real securities will become current in or by the bank, which will very much lessen, if not put an end to the credit of personal securities; for usurers will be content with such an easy, secure, and convenient profit, rather than hazard their principal, and embarrass themselves in trouble for a greater interest. Others of the learned tell us that this bank or fund will be so profitable, easy, and secure for receipts and payments, that all the money of the nation will naturally run into trade, and none will be left to purchase land, since men may continue their money in bank, on demand, upon the best security in Europe, and yet have a daily interest running upon it, and thus have trade and real estate at once."

"To conclude," he says, "reproaches and aspersions on such a work as this are neither new or strange, as being the common fate of all good and generous undertakings that are, or ever were in the world—the nature of men being bent against everything which they fancy innovation; as well out of a fond and presumptuous principle that they have known, or at least ought to know, more than others, as out of a natural unbelief or suspicion of all they cannot see, which makes them follow success, or anything like it, more than reason, and example more than rule. But the apprehension and difficulties which were in the way have not discouraged the proposers from doing their utmost to bring the designed work to perfection, which seems to be reserved for such a time as this, the better to enable the Government and people of England to revive, recover, and transmit to posterity the virtue, the lustre, and wonted glory of their renowned ancestors; and to lay a foundation of trade, security, and greatness within this kingdom for the present and succeeding ages."

Such were the objections made to the establishment of a great National Bank in this country. Still the project was brought to a successful issue, and on the 27th July, 1694, the Royal Charter of incorporation of the Bank of England was issued, and within ten days of the opening of the books, the subscription was full. Among the subscribers was the celebrated John Locke, who hurried up on the tenth day, that he might be in time to give in his name for £500, thus, like a practical philosopher, testifying his faith in the success of the new institution.

The business of the Bank of England was at first conducted in Mercers' Hall, and afterwards in Grocers' Hall, with a very moderate staff of clerks, secretaries, &c., to the number of fifty-four. Addison saw them at work in Grocers' Hall, and thus chronicles the fact:—"I looked into the great hall where the bank is kept, and was not a little pleased to see the directors, secretaries, and clerks, with all the other members of that wealthy corporation, ranged in their several stations, according to the parts they hold in that just and regular economy." Such was the precursor of the mighty establishment now carrying on its business, with thousands of clerks, in Threadneedle Street.

Among our *social* reforms and improvements, the institution of the Metropolitan Police, or "New" Police, as they were at first called, and the measure for a uniform Penny Postage, are conspicuous both for the opposition with which they were at first received, and the general satisfaction with which they are now regarded.

The old "Charlies," as the watchmen were called to whom the care of the lives and properties of the inhabitants of London was confided prior to the year 1828, may live still in the recollection of some of our readers. They were called "Charlies," in the language of the vulgar, from having been instituted in the reign of Charles I., just as our police are now called "Bobbies" and "Peelers" from their founder, Sir Robert Peel. Here is a brief description of them, taken from the "Quarterly Review" for June, 1856:—

"Most men who have arrived at that age, when the last one or two buttons of the waistcoat are allowed to be unloosened after

dinner, can remember the time when the safety of life and property in the metropolis depended upon the efforts of the parochial watchman, a species of animal after the model of the old hackney coachman, encumbered with the selfsame drab great-coat with countless capes, with the selfsame Belcher handkerchief or comforter, speaking in the same husky voice, and just as sottish, stupid, and uncivil. At night—for it was not thought worth while to set a watch in the day time—the authorities provided him with a watch-box, in order that he might enjoy his snooze in comfort, and furnished him with a huge lantern, in order that its rays might enable the thief to get out of his way in time. As if these aids to escape were not sufficient for the midnight marauder, the watchman was provided with a staff, with which he thundered on the pavement as he walked, a noise which he alternated with crying the hour and the state of the weather in a loud singing voice, and which told of his whereabouts when he himself was far out of sight.

"Up to the year 1828, and indeed for ten years later, in the City, these men were the sole defence by night of the first metropolis of the world. The Charlies, as they were familiarly termed, had very little fight in them at any time, but it is well known that they 'winked hard' when required to do so by people who could afford to pay them for it. It is not astonishing that crimes under such a police flourished apace, or that robberies increased to an extent which alarmed all thoughtful people. Mr. Colquhoun, a magistrate, whose work on the police, written at the beginning of the century, gave the first ideas of the reforms which have been since adopted, estimates that the annual value of the property stolen at the time at which he wrote was at least £1,500,000; and that the evil was gaining ground may be judged from the fact that the numbers of receivers of stolen goods had increased, between 1780 and 1800, from 300 to 3000!"

Such being the condition of things, we are now astonished at reading of the opposition made to Sir Robert Peel's measure for the establishment of a new system of police, which was happily made law in the year 1829. The new force introduced for the repression of crime was represented as being utterly unconstitutional; it took away from vestries and other bodies a certain amount of patronage, and was therefore denounced as being a scheme for the ministry to make themselves absolute, and triumph over our political liberties. Now, we are not going to say that our police system is perfect—far from it; but compare it with the old system as initiated in Charles I.'s time; compare it with the police under Elizabeth, when the first organized constabulary were introduced (if organized they could have been called); compare it, again, with the age of Henry VIII., during whose reign as many as 72,000 persons were hanged for theft alone in England;—a time, be it borne in mind, when the entire adult male population of England amounted to only about a million and a half of persons!—and what a paradise of safety has our London become, under the sheltering wings of Colonel Henderson and his few thousands of police-constables, almost unarmed, but thoroughly well disciplined and ready for any emergency!

Sir Rowland Hill's scheme for a uniform and low rate of postage was first laid before the public in the year 1837, in a pamphlet entitled, "Post-Office Reform: its Importance and Practicability." The principle of uniformity and cheapness, which was clearly laid down in this publication, immediately attracted general notice. From calculations which he had made of the number of letters passing between London and Edinburgh, as well as other places, the author showed that the principle of uniformity and cheapness might be safely relied on, and that although the revenue might suffer at first from the reduction of the average inland postage of 9*d.* to 1*d.* still that eventually the exchequer would be more than reimbursed from the vast amount of extra correspondence that would be carried on throughout the three kingdoms.

Although favourably received by the merchants and bankers, the post-office authorities immediately derided the new scheme when it was laid before them. Lord Lichfield, then Postmaster-General, said of it in the House of Lords:—"Of all the wild and visionary schemes which I have ever heard of, it is the most extravagant." On another occasion, speaking of the increased number of letters, he said:—"The mails will have to carry twelve times as much in weight, and therefore the charge for transmission, instead of £100,000 as now, must be twelve times that amount. The walls of the Post-office would burst; the whole area in which the building stands would not be large enough to receive the clerks and letters." Notwithstanding this opposition, however, when brought before Parliament and referred to a Select Committee of the House of Commons in 1838, the report was decidedly in favour of the scheme, the Committee declaring, "That the principle of a low uniform rate is just in itself; and when combined with prepayment and collection by means of a stamp, would be exceedingly convenient and highly satisfactory to the public." Eventually the proposal was embodied in a bill brought in by the Chancellor of the Exchequer himself, which passed the House of Commons by a majority of 100, and became law on the 17th of August, 1839.

When the measure was under discussion in the House of Commons, even Sir Robert Peel, although he did not absolutely oppose it, spoke of it in disparaging terms, quoting the opinions of Lord Lichfield, before mentioned, and of Colonel Maberley, Secretary to the Post-office, against it. That of Colonel Maberly was to the following effect:—"He considered the whole scheme of Mr. Hill as utterly fallacious; he thought so from the first moment he read the pamphlet of Mr. Hill; and his opinion of the plan was formed long before the evidence was given before the Committee. The plan appeared to him a most preposterous one, utterly unsupported by facts, and resting entirely on assumption. Every experiment in the way of reduction which had been made by the Post-office had shown its fallacy; for every reduction whatever led to a loss of revenue in the first instance. If the reduction be small the revenue recovers itself; but if the rates were to be reduced to one penny, the revenue would not recover itself for forty or fifty years!"

With such an official at the head of the Post-office, it was only natural that the new measure should receive considerable discouragement when first brought into practical operation. Indeed, this continued to be the case for some years. The officials who had to work it proved to be, as Mr. Baring expressed it, "unwilling horses." Colonel Maberly himself virtually acknowledged this. "My constant language," he says, "to the heads of the departments was,—'This plan we know will fail. It is your duty to take care that no obstruction is placed in the way of it by the heads of the department and by the Post-office. The allegation, I have not the least doubt, will be made at a subsequent period, that this plan has failed in consequence of the unwillingness of the Government to carry it into fair execution. It is our duty, as servants of the Government, to take care that no blame eventually shall fall on the Government through any unwillingness of ours to carry it into proper effect.'" Such was indeed their duty, but they notably failed to discharge it, and Mr. (afterwards Sir Rowland) Hill had a very up-hill battle to fight in endeavouring to secure the ultimate success of his measure. That success, however, came in due time. Moreover, it came in the lifetime of its author, and it has been not only satisfactory, but splendid. Every civilized country has adopted the principles and method of postage laid down by Sir Rowland Hill, and wherever adopted, these have proved eminently successful. In our own country—according to the latest return—the estimated revenue from the Post-office, for the year 1872-73, amounted to as much as £4,770,000; and in 1871 the number of letters delivered throughout the United Kingdom reached the enormous amount of 917,191,000!

Shall we pursue the subject? Need we speak of our Thames embankment and purification, our electro-plating process, our steam-hammers, our mighty war steamers, our enormous projectiles, our electric telegraph which puts "a girdle round the earth in (less than) forty minutes?" All these and numerous other inventions and projects which we now see in full operation, would in former years—and that not so long ago—have been relegated to the region of the *impossible*.

As to the success of the electric telegraph, it may be mentioned that in 1872 there were as many as 5,098 telegraph stations throughout the United Kingdom; and that in the previous year the number of messages forwarded from the different stations reached the enormous sum of 11,700,000! But how was this wonderful invention treated by some of our legislators, when it was first brought under their notice? Let the Duke of Somerset inform us. In a discourse lately pronounced by him at a distribution of prizes for art and science, the noble Duke says:—"I come to another thing—the electric telegraph. Here is another triumph for science, and in our own memory; and so much within our memory that I was on the Committee of the House of Commons when Mr. Wheatstone came to give us information of his plan of the electric telegraph. I remember we asked him a number of questions—how he could send messages to Edinburgh and so on, and at last some member asked, 'Now, really do you think you could send a message from Dover to Calais?' Upon which another member of the Committee said, 'Now, don't waste our time in asking such foolish questions.'"

Let us only finally mention the introduction of gas as an illuminator of our streets and houses.

We have but just lately recovered from the panic occasioned by a partial strike among the gas-stokers of London. Half the gas-lamps in our streets were extinguished, and the others gave only a flickering glare. At the theatres the finest effects proved ineffective, elderly gentlemen in the club-rooms could not read the evening papers, and our wives and daughters—the fairest part of creation—were driven wild in attempting to dress themselves

for evening parties. But there was a time when no such thing as gas, used as an illuminating agent, was in existence.

It was an engineer named Murdoch, residing at Redruth in Cornwall, who first brought it into practical operation. In the year 1792 he constructed a small gasometer and apparatus for lighting his own house and premises in that remote country town. In 1797 he had removed into Ayrshire, where he constructed a similar apparatus for his own residence. In the following year he was employed by Messrs. Watt and Boulton to set up a gas-work for their manufactory at Soho, Birmingham. This was the first experiment of the kind upon a large scale which had been made, and it proved eminently successful. In 1802, upon the occasion of celebrating the peace, the front of the Soho manufactory was brilliantly illuminated with gas, thus forming a contrast with all the neighbouring buildings, which were only dingily lighted with the old oil lamps. All Birmingham flocked to see the spectacle, and the newspapers teemed with commendatory notices of the new invention. It was adopted in other manufactories in Birmingham. Manchester, Halifax, and other towns followed the example. In a single cotton-mill in Manchester upwards of 900 burners were employed, giving a light equal to that of 2,500 candles. Murdoch, who had erected the apparatus, sent an account of it in 1808 to the Royal Society, and was rewarded for his enterprise with the Society's gold medal.

Still, the invention made little or no progress in London. It was not until an enterprising speculator named Winsor, a German by birth, took it in hand, that it appeared at all likely to be received with favour in the metropolis. This new agent, every one said, was dirty, had an ill smell, produced headaches, and spoiled both pictures and furniture. This was a heavy indictment, but as true as it was severe. Nevertheless, in 1804, Winsor succeeded in establishing a company for supplying London with gas, and eventually succeeded in purifying it by means of lime, so as to make it more acceptable to the public. In 1807 he lighted up Pall Mall with gas, but that continued for a long time to be the only street so lighted. Notwithstanding this first success, even Sir Humphrey Davy, the greatest chemist of his age, denied the possibility of lighting the streets of London safely with coal gas. And in this opinion he was joined by such eminent men as Wollaston, Watt, and Lord Brougham. But what do we now see? Not only do we see London, but every small town, and almost every village in the United Kingdom, now lighted with gas. Even in our country residences, railway carriages, and street tramway conveyances, we find it employed, not alone usefully, but with the utmost safety and convenience.

Thousands of workmen are constantly employed in its production, and its commercial success has been such that investment in a gas company is generally regarded as an excellent speculation. To supply London with gas there are now as many as ten companies in full and prosperous operation. From a return recently published in accordance with the requirements of the Board of Trade, we find that the aggregate capital of these companies amounts to as much as £8,775,557, paying a dividend of £8 12*s.* 5*d.* per cent.

ACTION of Sunlight on Olive Oil.—By Luigi Moschini. (*Gazetta Chimica Italiana*, i., 580. *Journ. Chem. Soc.*, 2nd series, ix., 1192.) Olive oil in its natural state contains in solution a yellowish substance which, when the oil is treated with acids or with caustic soda, gives rise to the well known greenish coloration. By exposure to sunshine this colouring matter is essentially altered, the oil being thereby decolorised and no longer exhibiting a greenish colour when treated with the agents above mentioned. Moreover, other changes take place at the same time in the constituents of the oil; the olein in particular being greatly altered, and acquiring the fundamental property of *elaïdin*, namely, that of not solidifying in contact with nitrate of mercury mixed with nitrous products. At the same time free acids are formed, and the oil acquires a rancid taste and odour.

From these results it appears that the method, suggested by some authors, of distinguishing olive-oil from other oils by means of sulphuric acid, caustic soda, and nitrate of mercury, can be depended upon only when the oil is in its natural state, not altered by exposure to sunshine.

TREATMENT of Burns.—M. De Bruyne recommends the following in cases of burns in place of the carron oil and similiar applications: fresh hydrate of lime, 3 grammes; glycerin, 150 grammes; chlorinated chlorhydric ether, 3 grammes. The mixture is transparent and uniform, and is applied to the injured part by means of a piece of fine linen, over which may be laid oiled silk or other material to prevent evaporation.

RECENT PROCESSES FOR THE MANUFACTURE OF GAS FOR ILLUMINATING PURPOSES.

WILLS gave a lecture on the 21st of May, before the Society of Arts, wherein he discussed the causes that have combined to make the last two years a time favourable for the introduction of new schemes for the manufacture of gas, viz., the perhaps partially groundless fear of exhaustion of coal-beds; the tendency of the coal market to push up prices to an extent out of all proportion to the necessity; the fact that gas companies have been occupying a very difficult position of late, partly on account of suspicions of mismanagement and partly from the results of other causes, a position of which advantage has been taken by the *employés;* and the belief entertained by some that the present modes of manufacturing gas are unscientific and wasteful. In consequence, various new schemes have been proposed for the production of illuminating gas, some of which the lecturer discussed at length, with reference more especially to the scientific aspect of the processes, and not to their commercial success or otherwise.

The possibility of producing gas from coal and analogous bodies by destructive distillation depends on the power which complex organic substances possess of breaking up by heat into a number of simpler bodies. The higher the heat the greater is the tendency to produce hydrocarbons containing much hydrogen in relation to the carbon, and even free hydrogen; thus the following table represents the composition of gas evolved from coal, at different temperatures, per 100 of hydrogen:—

Temperature.	Hydrogen.	Carbon.	Character of Gas.
Dull red heat	100	614	Chiefly olefiant gas (C_2H_4).
Red heat	100	580	Mixture of olefiant gas
Bright red heat	100	472	and marsh gas (CH_4).
White heat	100	325	Marsh gas.
Continued white heat	100	?	Nearly pure hydrogen.

The gas actually supplied has a composition indicated by the following analyses:—

	Great Central.	Imperial.	Chartered.
Illuminating hydrocarbons	3·56	3·67	3·53
Marsh gas	35·28	40·66	35·26
Hydrogen	51·24	41·15	51·80
Carbonic oxide	7·40	8·02	8·95
Carbonic acid	0·28	0·29	—
Nitrogen	1·80	5·01	0·38
Oxygen	0·44	1·20	0·08
	100·00	100·00	100·00

According to the temperature of distillation, very different quantities of gas and tar can be obtained from the same coal, thus:

Temperature of Distillation.	Gas obtained.	Tar.
Very low red heat	7,500	150 lbs.
1,300—1,400 F.	8,300	120 „
Bright red heat	9,500	70 „

In 1871 a patent was taken out for the distillation of coal at a lower temperature than that usually employed, whereby a gas rich in illuminating constituents is obtained comparatively free from "*residual* sulphur impurity." The tar, collected by special contrivances, is separately destructively distilled, whereby gas and condensable products are obtained; these condensed substances are again distilled, and so on until the tar is wholly converted into vapours and pitch. Messrs. Keates and Odling have examined this process, with these results:—At 1300°—1400° F. the highest yield of gas was 9,775 cubic feet, one ton of coal (Silkstone) giving 16·4 gallons of oil, Clay-cross Main furnishing 11·9, and Pelaw Main, 13·9 gallons, the mean lighting power of gas from coal being 23·0 candles, that from tar being 25·0 candles. About 33 per cent. of coke is obtained, a further quantity being produced by the subsequent distillation of the tar. It appears very doubtful whether the tar is not worth more, as such, than as gas when converted as by this process.

In another process the gases, &c., from the retorts are led through heated iron pipes filled with pumice-stone or coke, whereby the same result is produced as in the above process, viz., the conversion of much of the tar into gases; superheated steam is driven into the retort in accordance with the principles involved in what is termed "White's hydrocarbon process," whereby an increase in the produce of gas from a given weight of coal is obtained, together with an increase in the

illuminating power of the gas and a decrease in the amount of tar formed.

In order to carbonize the coal as rapidly as possible (which is essential to the effectiveness of the gas-making operations), various plans have been employed, such as making the bed of the retort into a constantly moving stage, on to which coal in small pieces is constantly dropped. One of the simplest plans is to use a vertical retort inside which works a broad and deep screw, the thread of which is at an angle of 45°, and nearly touches the sides of the retort; the rate of revolution is so regulated that by the time the coal reaches the bottom of the retort it is properly carbonized, and is discharged as coke of inferior quality. The chief difficulties in this process appear to be mechanical, there being great friction in the screw; also the sulphur in the gas and coal gradually acts on the iron, which becomes brittle. The following results show that the process is to a great degree successful :—

Coal Carbonized.	Quantity of Gas obtained.	Illuminating Power.	Tar.
1 ton . .	11,040	16 candles	8·5 gallons.
1 „ . .	10,160	17 „	
1 „ . .	12,000	16 „	

Many schemes have been patented, the object of which is to increase the illuminating power of a gas by impregnating it with the vapours of volatile liquids; thus, in 1862, Mongruel took out a patent in France for the production of a gas consisting of air charged with the vapour of a light inflammable spirit to such an extent as to be capable of burning with a common flame. This idea was introduced into England by the Photogenic Gas Company, which, however, has not proved a success. One reason why this and other similar processes have not proved as successful as was anticipated is, that the volatile liquid is apt to condense again on exposure of the impregnated gas to a low temperature, or by passage through a great length of piping—in other words, such gas will not travel well. In selecting the volatile liquid, many inventors have assumed that the lower the specific gravity of the liquid the lower the boiling-point, and consequently the more volatile the liquid. This is true of certain series of hydrocarbons, but not necessarily of other bodies; *e.g.* alcohol, benzol, and bisulphide of carbon, have the specific gravities 0·719, 0·85, and 1·272 respectively. This volatility, however, is in the inverse order, bisulphide of carbon being the most volatile, and alcohol the least. In the case of petroleum distillates, the following connections subsist between boiling-point and specific gravity :—

Specific Gravity.	Boiling Point.
0·600	40° C.
0·628	30° „
0·669	68° „
0·699	92° „
0·726	118° „
0·741	136° „
0·757	160° „

The amounts of petroleum spirit of specific gravity 0·65 which is present in air at various temperatures are given by the following table:—

Temperature.	Percentage.
—10° C. (14° F.) . . .	5·7
0° C. (32° F.) . . .	10·7
+10° C. (50° F.) . . .	17·5
15° C. (60° F.) . . .	22·0
20° C. (68° F.) . . .	27·0
40° C. (104° F.) . . .	39·0

Air-gas (*i.e.* air impregnated with the vapour of this or of an analogous substance) cannot be burned from an ordinary bats-wing burner at the same rate as coal-gas; if it could, the illuminating power of such gas would be as high as thirty candles; such gas will not burn well under pressure, and can only be used with burners where there is a very free access to the air. Various means are in use for the impregnation of the air; thus, the air may be forced through a wire gauze grating, forming a false bottom in a tank of the volatile liquid. The division of the air into a large number of small streams facilitates its taking up the vapour; or the air may be passed over cotton-wool or sponges soaked in the liquid (the town of Great Marlow is at present illuminated by means of gas thus prepared). The simplest mode consists in placing trays with the volatile spirit inside a gas-holder with a valve at top; when the holder is raised, the air rushes in through the valve over the trays and becomes highly impregnated with vapour. One gallon of spirit is said to carburize 500 cubic feet of gas, the volatile liquid being the most volatile portions of American petroleum oil, mainly hydride of amyl (and butyl?)

The objection to these and similar processes, that the gas thus made will not travel far, but condenses in cold weather, applies to ordinary coal-gas, though not to the same extent. A great portion of the illuminating power of ordinary gas is derived from the presence of benzol and other volatile substances in the vaporous state; and in cold weather these condense in the pipes, greatly impoverishing the gas. The higher the illuminating power of the gas the greater is the loss thus experienced; thus, gas from Cannel coal loses much more of its illuminating power than gas from ordinary coal.

Instead of air, combustible gases may be used as a vehicle for the volatile substance; *water-gas*, or the mixture of hydrogen and carbonic oxide formed by blowing superheated steam into red-hot coke, together with hydrogen evolved by the action of steam on certain red-hot metals (*e.g.* iron), having been used for these purposes. Thus a patent was given in 1830 to Michael Donovan for the production of water-gas; one to George Lowe in 1831; a third to Gilbert Saunders in 1833; two others to Floret and Molerat about the same time; besides several others, only differing in some slight modifications. Recently, a process has been proposed, based on the production of water-gas and its subsequent carburization. Gas of illuminating power equal to sixteen or seventeen candles is produced, and its permanent character is stated to be so far marked as to render it of practical value. In the same way, coal-gas of poor quality may be carburized and enriched in illuminating constituents. By distillation of the coal at a high temperature a very large bulk of gas may be obtained, especially if a jet of steam be introduced during the carbonization; as much as 52,000 cubic feet have been thus obtained from a ton of coal, the illuminating power being four candles.

THE ROAD STEAMER "AMERICA."

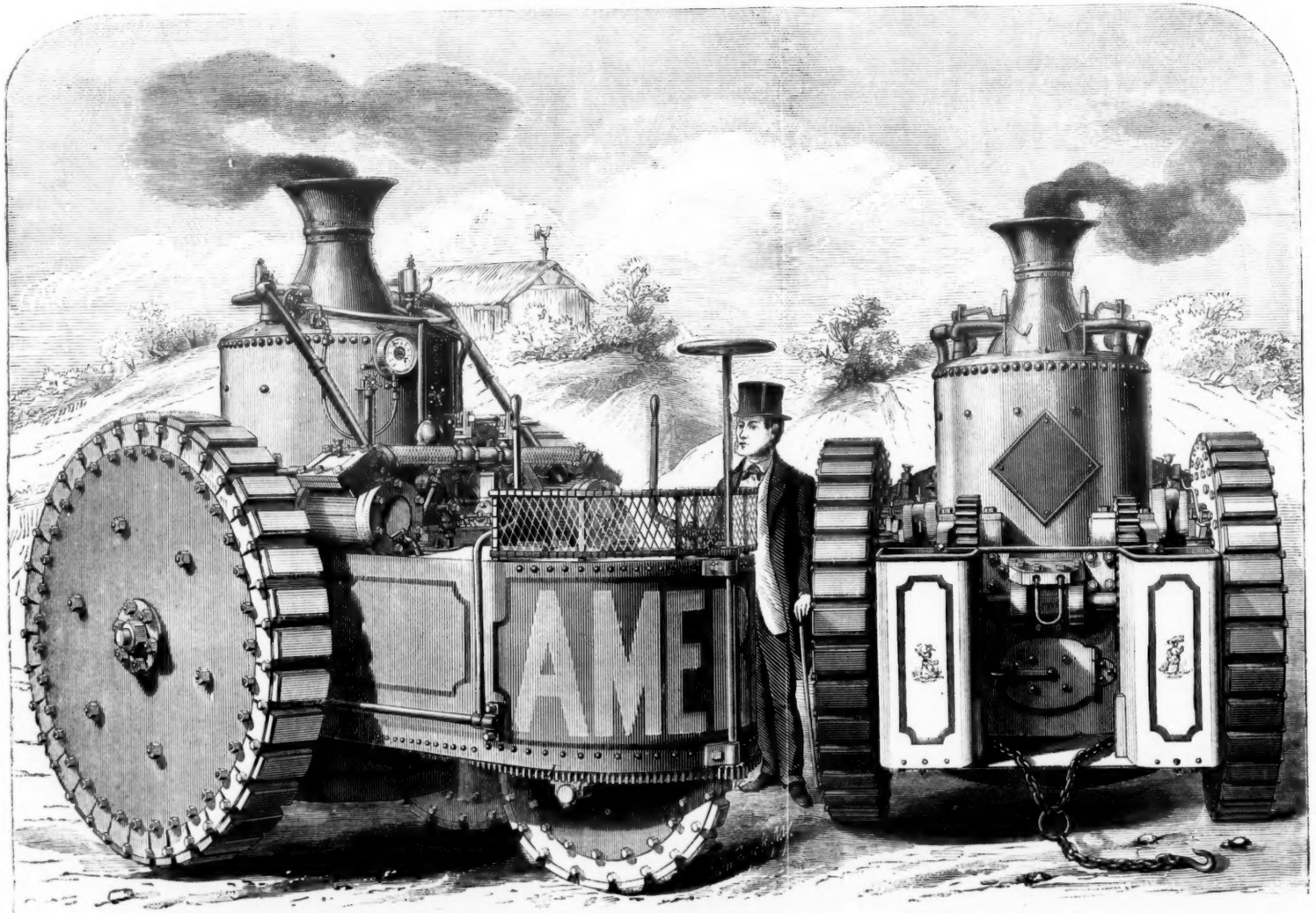
THE engraving gives a representation of a new road steamer, invented by Mr. George W. Fitts, of America, and upon which three patents have been granted.

There are (says the "Scientific American," from which this is taken) many good points in the design of this road steamer, aside from the peculiarities upon which the patents are based. The diameter of the driving wheels of the locomotive, as represented with side plates and rubber blocks, is about 66 inches over all. The diameter of the guide wheel is 31 inches. The boiler is 38 inches in diameter by 6 feet 6 inches in length. The total length of the machine is about 10 feet. The extreme width of track is 76 inches. The breadth of the faces of the driving wheels is 10 inches, and that of the guide wheel 6 inches. The capacity of the water tank is 250 gallons. The fuel bunkers carry hard coal for ten hours' labour. The cylinders are 7 × 12 inches. The total weight is from 7,000 to 8,000 lbs.

The structure of the driving wheels and the guide wheel (with the mechanism for operating the latter) being the most prominent features of the locomotive, we will first notice them.

The side plates are bolted to the hub of the wheel, as shown. There is a rim supported by bolts, the latter also holding the two side plates of each wheel together. These side plates are also braced between the rim and the hub, and they extend out beyond the rim, as shown. The space exterior to the rim, and inclosed laterally by the side plates, is divided into chambers or pockets by triangular partitions. The pockets thus formed are larger at their base on the rim than at the outer edges of the side plates. In them are placed blocks of elastic rubber. Around the outer extremity of each rubber block is placed a band or cap, corresponding in shape to the part of the rubber block inclosed. The inner portion of this band or cap is inclosed in the pocket, from which, on account of the inclination of the sides, it cannot escape.

These wheels are driven by gear wheels attached on their inner sides, as shown in the engraving. The steam cylinders are placed to the rear of the axle and above it, and the connecting rods pass over the axle to cranks in front of the axle, on the shaft of which are pinions which mesh into the gears that turn the driving wheels. The general construction of the guide wheel is like that of the driving wheels, with side plates, triangular partitions, pockets, and rubber blocks. Its axle has a yoke attached near the wheel, the yoke being pivoted at the top to the framework of the machine. The boxes of the axle are bolted to the under side of a toothed circle, which corresponds in its action to the fifth wheel of ordinary vehicles. The circle is made convex on the top, its convexity fitting a corresponding



THE ROAD STEAMER "AMERICA."

concavity in a fixed circle, which guides it in its movement about the central vertical axis. The pivoted yoke prevents the displacement of these two parts. A pinion meshes into the toothed circle, and is actuated, in steering, by a vertical shaft and hand wheel.

The general arrangement is more compact than that of other road steamers before the public, and is of such a form as will admit of its being constructed very light or very heavy, as may be desired; at the same time it is claimed that it retains all the necessary points for a successfully working machine. It is built with special reference to its adaptation to all the various uses to which a self-moving power may be applied; and it is claimed that it can be used, and is as well adapted for a local or stationary power as it is for a movable one, as by simply blocking up the driving wheels they may be used as band wheels for sawing wood, thrashing grain, shelling or grinding corn, or for any purpose where a stationary power is needed.

The driving wheels are, we believe, an entirely new invention. From actual trial the inventor considers them as good, if not the best, traction wheels that have been constructed. The points of merit claimed for this wheel are its great strength and lightness, the arrangement of the blocks of rubber in the face of the wheel to get the elasticity so much needed in a machine of this kind, combined with the most effective traction service, its simplicity of construction, and the arrangement of the triangular partitions, by which any of the rubber blocks may be removed and repaired by simply unscrewing a nut and removing the bolt which holds the partition in place, so that, if any part of the wheel or blocks should be damaged, it may be repaired without interfering with any other part of the wheel, thus making the cost of repairs much less than with other forms of rubber-tired wheels.

It is claimed that, in the peculiar construction of the guide wheel, a superior advantage in compacting the entire machine is attained, as this wheel may be placed in any desired position under the water-tank and entirely out of the way.

The machinery is all thrown around the boiler and directly upon the driving wheels by placing the cylinders upon one side of the axle of the drivers and gearing upon the opposite side, and we believe this is the only machine where this is accomplished.

The boiler is fed by a small steam pump, which is placed upon the top of the tank, and is used for a variety of purposes, such as feeding the boiler, filling the water-tank by attaching a hose pipe and throwing one end into a pond or well, &c. It will draw the water from the water-tank, and force it through the same pipe to the height of sixty or seventy feet. Thus it may at times be useful in putting out fires, washing, sprinkling, &c. It works entirely independently of the engines.

It is confidently expected by the manufacturers of these road steamers that they will be able to demonstrate its adaptability to travel upon common roads, and its usefulness for all the purposes for which traction engines are needed.

THE JET TRADE OF WHITBY.

By H. Curwen.

A PLEASANT ride of two-and-twenty miles through the finest scenery in Yorkshire was not an unpromising commencement to an inquiry—planned to last some days—into all the details and dry technicalities of an out-of-the way little trade. A cheering atmosphere; a clear sky; a sun, bright but not over warm; copses and hill-sides covered as they are nowhere else, with wealth of pale primroses; rugged headlands, bluff and naked, stretching far into the German Ocean; gills and valleys running deep into the land; occasional glimpses of water blue as an Italian lake, of sands yellow as the banks of Pactolus, of moors dreary and desolate; and an all-pervading influence of the beautiful infinities of the wonderful green colour that Maytime brings with it—these things, after a month of rains and clouds and dismal weather, exhilarate one as if they had never been seen before. After a fashion, too, there was plenty of human life astir, for this was the first day of a lock-out among Cleveland miners, that was likely to be disastrous, but now happily altogether historical. The villages, generally given over to innumerable children, are full of burly miners, pipe in mouth, lounging about with a perplexed, dazed look, as if not quite certain whether this was a holiday or a time of trouble. Brotten and Carlinghow were teeming with these men, sober, or drunk, or gloomy, or full of boisterous horseplay. Quoits and marbles seemed the prevailing amusements everywhere, but at a quiet corner these were superseded by a fight, conducted in the presence of a great crowd, with all the forms and ceremonies of the prize-ring. Lolling on the grass beneath the hedges, lay little companies of men discussing the gravity of events in language earnest but not parliamentary; and it was strange to see these Yorkshire giants, notorious everywhere for the foulness of their vernacular, carrying their little dogs as tenderly as a child might nurse a new doll, or plucking great bunches of primroses to take home to the "missus" or the sweetheart. Everywhere there were primroses—in their hands, their coats, their cottage windows—and there in the uncouthest vases that ever sent up perfume to the goddess Flora.

At Brotten I was informed by a bellman that a monster meeting was to be held at Skinning-grove; and there, on the sands where once the famous merman disported, I found a huge crowd of Cleveland miners receiving a deputation from the furnacemen, begging them to reconsider their demands, as otherwise the whole district would shortly be thrown out of employment. Interesting, however, as this representative gathering might be to all practical men, it was not to my present purpose, so on I hastened, past the celebrated fishing village of Staithes, and from thence I followed pretty closely the new railway line (Whitby and Saltburn), which, though in progress for so long, seems to have made but little real headway.

Nearly five miles off the town of Whitby I catch occasional glimpses, as the road winds hither and thither, of the bold *scar*, or cliff, surmounted by the grey ruins of St. Hilda's Abbey, and in a little further space, of the bright red roofs of its high houses. Continuing step by step, I see from different coigns of vantage, the various beauties of the site, till at last the old town bursts suddenly upon me in its quaint and almost mediæval picturesqueness. Lying on both sides of a harbour that divides two lofty hills—one of them, indeed, a towering cliff—the houses rise each above the other; these houses are tile-covered, very lofty, the streets very dark and narrow; old pieces of architecture interbuilt with more modern masonry; fishing smacks with listless sails lie in the water in the very middle of the town; the quays thronged with weather-beaten fishermen and covered with nets and lobster-pots; the streets full of men and boys in long blue blouses, and the whole *tout-ensemble* of the town is more foreign than that of any other English place I wot of. Indeed, Whitby reminds one strongly of Dieppe, not only as a fashionable bathing-place, or in the similarity of the jet trade, the staple of the one, to ivory carving, the staple of the other, but in its cliffs, its sands, its narrow wynds, its ruins, and its strange old style of architecture.

It was too late when I arrived to view anything of what I had come forth for to see, but I presented my letters of introduction, and was able that evening to make arrangements for future inspection, and to discuss the much vexed question of the origin of jet with some of those local authorities best acquainted with the subject.

Jet is of two distinct species—hard jet and soft jet—but the latter is of very minor importance, and will be referred to hereafter.

The hard jet is found in the strata known as the jet rock, and this jet rock occurs solely in Cleveland and the district south of Whitby—for as yet, at least, the existence of the true jet rock in Dorsetshire is scarcely more than problematical. The jet rock belongs to the lias formation and is found from ten to thirty yards above the main Cleveland band of ironstone. It occurs in irregular seams, varying from twenty to thirty feet in thickness, its appearance being indicated by what the miners call a "clogger," and it is co-existent, but at strange intervals, with the whole of the Cleveland ironstone. This jet rock appears to be a deposit of sea anemones, and some years ago a patent was taken out to distil petroleum from it. The investigator's experiments proved that ten gallons of oil could be extracted from one ton of shale, and that this oil was a pure vegetable oil, burning with a clear, brilliant light. The cessation of the American war, however, gave a great impetus to the American petroleum industries, and rendered the Whitby scheme impracticable.

In this jet rock, then, the hard jet is found as a deposit, being, according to some authorities, merely the result of a distillation by igneous action from the rock itself; and they urge as grounds for this belief that it is invariably found in a horizontal position, spreading thinly out as water might have done. The outer surface, however, is always marked with *striæ* like the grain in wood, and the transverse fracture, which is conchoidal and has a resinous lustre, displays animal growth in compressed elliptical zones. Others, again, declare their belief that hard jet is of a pure ligneous formation in another mode to that of coal—perhaps, indeed, undeveloped coal—for coal and jet are never found co-existent. The mine-owners themselves, however, put some faith in both modes of origin, and believe that this hard jet is of

two distinct formations, having been either wood or petroleum, but now in a state of high bitumenization.

Mr. Simpson, the curator of the Whitby Museum, who paid much attention to the subject some dozen years since, formulated his theory as follows :—

"Jet is generally considered to have been wood, and in many cases it undoubtedly has been so ; for the woody structure often remains, and it is not unlikely that comminuted vegetable matter may have been changed into jet. But it is evident that vegetable matter is not an essential part of jet, for we frequently find that bone and the scales of fishes have also been changed into jet. In the Whitby Museum there is a large mass of bone, which has the exterior converted into jet for about a quarter of an inch in thickness. The jetty matter appears to have entered first into the pores of the bone and then to have hardened ; and during the mineralizing process, the whole bony matter has been gradually displaced, and its place occupied by jet, so as to preserve its original form."

This process has, however, been much disputed, and when eminent geologists differ we may be allowed to pause respectfully, and to confine our remarks to what has been positively ascertained.

We know, then, that hard jet is found in the jet rock, and that this jet rock occurs in the lias formation, some thirty yards above the main band of Cleveland ironstone, and we can see for ourselves that it is discovered in compressed masses in layers of very different sizes, being generally from half an inch to two and a-half inches in thickness, from four to thirty inches wide to four or five feet in length. It invariably tapers away, running, as the miners say, to a "feather edge." The largest piece ever exhibited at Whitby was six feet four inches in length, four and a-half to five and a-half inches wide, and one and a-half thick, weighing eleven pounds and a-half. The nett price was ten guineas, and at this figure it was offered to the curator of the British Museum ; he declined to purchase, and the owner, loth to sell such a specimen in the market, kept it a twelvemonth, and at last reluctantly sold it for fourteen guineas to be cut up into four-inch crosses.

These jet layers are always protected by a skin, the colour making another division; for that found in the cliffs by the sea has always a *blue* skin, while that discovered in the inland hills has a *yellow* coating.

The jet found in the same mine varies very much in quality ; its worst specimens, those which are quite brown and will not take a polish, are termed "dazed jet."

The soft jet is confined to the lower oolite—in the sandstone and shale—some 160 yards higher than the hard jet, and is undoubtedly of a pure ligneous origin, the fibre and the branches of trees being more or less distinctly marked. I was fortunate enough to have the opportunity of inspecting the finest known piece of soft jet, which consists of the split half portion of a large tree, with two distinct branches still attached, and every fibre, and four or five regular knots, clearly preserved. This weighed no less than three stone, and was two feet eight inches long by one foot broad, and from two and a-half to nearly three and a-half inches in thickness. Like most of the soft jet now in use, it had been imported from Spain ; for, unlike the hard jet, the soft is found in many parts of the world, notably on the slopes of the Pyrenees. This soft jet is mined in a manner similar to the other, but it sometimes crops out of the surface, having, indeed, been ploughed up in the fields near Bilsden. It will not be necessary to draw any distinction between the two in the description of the processes.

The district of jet "scaaur" that has yet been worked, or at present working, extends along the coast for some fourteen miles north of Whitby and eight miles south, and is carried for twenty miles inland from a mine ten miles north of North Allerton, till the seam of jet rock breaks a little south of Stokesby, at the pretty village of Inglesby.

The Mulgrave estates generally, and especially Mulgrave Cliff, are noted for their jet, and its occurrence here was commemorated by Drayton, in his *Polyolbion*, as far back as the early part of the seventeenth century :—

> "The rocks by Moultgrave, too, my glories forth to set,
> Out of their cranied rocks can give you perfect jet."

The most valuable finds of jet have been washed down by the sea's action, where the jet rock crops out in the cliffs ; and on the cliffs, where the seams are exposed. The ordinary method of obtaining the article is that of "dessing," or following up the given clue. In the inland Cleveland Hills the front of the rock is turned down bodily and exposed ; then the hill sides are tunnelled as the indications direct.

The dealers of the town of Whitby rent these jet cliffs and inland seams from the owners, generally for a fixed lump sum paid in advance—not for a royalty—for the right to work a certain number of yards. Nearly all the jet now obtained is found inland, but in former days tales are told of men being swung by ropes over the steep cliffs like the eider-down hunters of Norway. At present, cliff-jet is worked with the same mining operations as that lying under the inland hills.

The process is very simple, and, to those acquainted with the intricacies of iron and coal mining, of no very great interest. The most extensively worked mines are those of Bilsdale, near the village of Broughton. Here the visitor, after a long climb up the hill, finds himself at the entrance of the pit—a narrow passage of some seven feet by five. All around there are evidences of old workings, which usually go in for some seven or ten yards, and the miner must tunnel beyond these before he can expect to reap a reward. Stories, of course, are plentiful of large sums having been made from taking up a mine with which a former master had been disgusted. A mine is commenced by drifting into the face of a rock a passage of seven feet by five. A tramway is then laid down, and the shale is tilted from the mouth of the mine. The drift is continued for about forty yards, at the rate of from two to four feet *per diem;* then cross drifts are started in a variety of directions. As soon as the rock becomes too hard the miners retire, pulling in the roofs as they recede, for the bulk of the jet is found generally in the falling top-rock.

This is a general process, but here follows a description of a visit to the Bilsdale mines. Entering the narrow doorway, one splashes and wades through the numerous little puddles that have accumulated. One knocks one's head against the low roof here, or scrapes one's ribs and elbows against the narrow wallings there. Now escaping breathlessly, now waiting in the painful darkness till the little waggons pass by, one manages to see a man pulling down a roof on one side, or quarrying his way in to the earth on the other. At last a seam of jet is pointed out—lying always horizontally—which a third is following up. As soon as the "black diamond" is found, it is taken out in pieces as large as possible, and placed in a bag kept conveniently near, and removed each evening to the jet-master's house.

There are at present twenty-three jet mines in full work, only one of these being of soft jet. The average number of men employed in each mine is six, and there are now some hundred and fifty miners engaged in this industry. The men are generally paid by the week, and only earn from twenty-four to twenty-six shillings—a sorry contrast to the high wages of the iron miners. Indeed, for this reason it is almost impossible to work the jet mines in close proximity to the iron districts, as it is difficult to overcome the temptation to desertion. The jet miners, however, are mostly old hands, and there is a kind of domestic pit-life in these quiet little workings that has probably some charm of its own. The men usually go to work very early in the morning, and stay nine hours, working eight ; but when a very valuable seam is found, it is the custom to work night and day in alternate companies. The master finds all tools except shovels. The capital required for jet mining is not large. The "plant," of half a dozen narrow little waggons and some hundred yards of tram lines, is far from costly. Were it not for the precarious nature of the venture this branch of mining could surely be worked on a purely co-operative system among the men themselves. After a certain fashion co-operation has been tried in two distinct ways : in the first case the men received ten shillings a week and one half the net profits ; in the second, they had no regular wage, but divided amongst them five-sixths of the net profits.

Jet is very often found in sinking an iron pit, but in these cases it is a regular perquisite of the finder, who disposes of it to some petty dealer.

The jet mines are generally owned by men who are themselves dealers, or by those who employ a dealer or broker to dispose of their ware, and by these brokers the whole of the manufacturing trade are supplied.

Hard jet varies in price from 3*s.* to 14*s.* per lb. ; soft jet from 5*s.* 6*d.* to 30*s.* per stone, according to size and quality, and sometimes also according to the fluctuations of the market. For instance, when the Prince of Wales's life was in danger Whitby was thronged with buyers for both the raw and manufactured article at any price, and some speculators were severely bitten by his happy recovery.

I was informed by one of the largest dealers that the turn-over in rough English hard jet amounts to £40,000 annually.

I have already mentioned that there is only one soft jet mine now at work. The reason of this change is simply this : the Spanish soft jet has driven the English from the field, and threatens to damage even the hard jet trade. This Spanish jet is despatched from Bilboa, Tarragona, and Barcelona to London, where it is sold in Mincing Lane, the whole of it eventually coming to Whitby in the rough state. It can only be used for the coarsest work, for it is so strongly impregnated with sulphur

(of which it smells) that it not unfrequently "explodes" (cracks and splinters) after manufacture.

Having thus treated the raw material with such fulness as my space allows, I come now to the history and description of jet as a manufactured article of commerce.

By the ancients jet (presumably soft jet) is said to have been first found at Gages, in Lycia, and from this it was called Gargates, later on taking the descriptive title of black amber. Solinus and Bede both speak of jet being obtained in Britain, and Camillus Leonardus, in his "Mirror of Stones," tells us that "the smoke thereof drives away devils, dissolves spells and enchantments, helps the despairing, banishes serpents, &c., and when bruised is available in many female complaints, as well as potent to heal the bite of a snake if mixed with the marrow of a stag," uses of which the good people of Whitby are strangely forgetful, and which none the less are fully supplemented by Cædmon, as thus translated :—

> "Jeat-stone almost a gem the Lybians find,
> But fruitful Britain sends as wondrous kind—
> 'Tis black and shining, smooth and even, light,
> 'Twill draw up straws, if rubbed till hot and bright ;
> Oyl makes it cold, but water gives it heat."

Jesting apart, Cædmon is perfectly right when he hints at its electrical properties.

Jet beads are found in company with the skeletons in the Yorkshire tumuli, and a row composed of different sizes was recently disinterred, proving that the beads had in this way, then as now, been strung together. During the period when Whitby Abbey was a seat of learning, and the resort of pious pilgrims, there cannot be much doubt but that jet crosses and rosaries were common.

There is reason to suppose that in Queen Elizabeth's reign there was some local trade in jet ornaments, and in the year 1598 the name of "John Carhill, Jet Worker," occurs in a list of the principal citizens of Whitby. The art, rough as it was, judging from existing specimens, however, died out, and was not revived until the year 1800, when John Carter and Robert Jefferson, a painter, made beads and crosses with files and knives. Indeed, until five-and-thirty years ago—and here I speak from the words of those who were then in the trade—there were only two establishments at Whitby, employing some twenty-five hands. Little by little the demand increased, and the manufacture of the Whitby staple progressed. The early history of the trade is interesting, and as Mr. R. Hunt investigated the following local account, written in 1854, and found it thoroughly trustworthy, I will transfer the paragraph almost intact :—

"About the year 1800 a painter named Robert Jefferson, who is still living, and one John Carter, who kept a public-house in Haggersgate, a native of Bedale, and who is often spoken of by the name of Katterfelts . . . began to make beads and crosses of jet with files and knives. A neck-guard made in this barbarous manner was sold for a guinea. A short time afterwards a Captain Fremlett, a naval pensioner, came to reside at Whitby, who, stopping in Carter's house, observed Jefferson and Carter pursuing the trade in its rude state. He showed them some amber beads which he had turned with a lathe, and said he would ask some turner if jet could not be turned the same way. The trio went to one Matthew Hill, who succeeded in making beads, but had no confidence that the art could be pursued to profit. Fremlett, however, agreed to pay him his wages as a turner if he would work for him in the making of jet ornaments. Subsequently Mr. Thomas Yeoman, silversmith and druggist, employed Hill's whole time in the manufacture ; and business increasing, one Frederick Ward, who had been taken up by Carter to assist him in his inn, went to work with Hill. Mr. Yeoman afterwards employed Foster, another turner. Others then entered the ranks, the next being George Harrison, a cartwright," &c. &c.

But it was not until the years 1849-50 that any really artistic advance was inaugurated. At that time a most ingenious workman, Mr. Varley, was the acting manager of Mr. Isaac Greenberry's works, and, fired with the prospect of the forthcoming Exhibition, he wrote to Mr. S. C. Hall, editor of the "Art Journal," for advice upon the nature of the articles that should be displayed. Mr. Hall, ever zealous for the progress of industrial art, entered heartily into the project, and sent down Mr. Strudwick and two other artists of his staff to draw original designs. These were followed by another gentleman engaged upon the same periodical, Mr. Hunt, the scientific writer, who described the improvements when carried into execution.

From this period a rapid progress may easily be traced ; natural foliage in every conceivable combination has been adopted, together with figure groups, cameo busts, coral sprigs, and carvings in ivory, paintings on enamel, embossed devices in gold, silver and aluminium, to be introduced upon a groundwork of jet.

Although special designs have, time after time, been attempted, none have been so really successful as patterns as the common vegetable and floral forms. The attempt to compete with metal workers has been a failure, and a decided change has taken place towards a greater solidity, and the best workmen are imitating Roman cameos and antique gems, but in deeper relief than in the originals.

During my sojourn at Whitby I experienced the greatest courtesy at the hands of those manufacturers to whom I applied for information, and had opportunities offered, and of course accepted, of visiting the chief workshops in the town. It was, however, pointed out by some of the firms, not so well known to retail dealers as others, that, in a small, compact business like the jet trade, nearly all the members of which were assembled in one town, all very keen in rivalry, and all by travellers and other legitimate means endeavouring to attract the notice of the retail dealers, the mention of any individual names would be not only invidious to many unnoticed, but might prove disastrous to those who had themselves been most forward in their good offices. I shall therefore avoid names altogether, using in one or two cases such initials as may identify the persons intended only to members of the trade already cognizant of the facts—to the outside world, indeed, one vague symbol will be as good as another.

The manufacturing establishment of Mr. C. B. then, after this proviso, may, as it is by far the largest, be fairly taken as the best possible sample. Mr. C. B. has himself served a long apprenticeship (more than thirty-five years), and has passed through every grade to which jet workers are liable, culminating in the proud position of the father and head of a very interesting artistic industry.

The jet is first peeled and stripped of its skin, be it blue or yellow, by means of a manual chipping process with a heavy iron-handled chisel. It is then sawn up into the exact sizes for the objects for which it is intended, the saw being guided by an ingenious arrangement of little wooden directors. Much care is taken in this process of "sawing up," for great economy can by rigid supervision be effected, one manufacturer telling me that by a very simple arrangement he was able to make his raw material go a fifth further than any of his rivals. The little fragments are then delivered to workmen, who, with the aid of small grindstones driven by a foot treadle, take off the angular portions and reduce them more nearly to the required dimensions. They then pass into the hands of the carvers, who with knives, small chisels, and gouges, soon, if it be rough work only, cut them into the desired pattern. If the work, however, be really artistic the carving is of course a much more artistic process ; and it is curious to see lads and men, who one might fairly think had not the slightest knowledge in the world of art principles, cut deftly and rapidly cameos that in their beauty of profile resemble the old masterpieces ; flower-scrolls and groups of fruit that have a marvellous fidelity to nature herself ; and crucifixes and pendants that rival all the ingenuity and patience of the "heathen Chinee." Sometimes you notice them with a pattern placed before them, or with a rough design scratched by a knife's point upon the material itself—oftenest, however, it would seem as though the work was altogether original. And yet Mr. C. B. declared that he was willing to take fifty little London street Arabs as apprentices, and able, too, to guarantee that more than half of these should turn out first-rate designers. After being carved the goods are removed to the polishing room, where the first process, in the case of rough goods, again takes place, upon a treadle grindstone fed with oil and "rotten-stone." Then the finish and the polish are given by what is termed "rougeing." Here the articles are held against quickly-revolving wheels, covered with chamois leather for the larger portions and with strips of list for the indented parts of the pattern, the beautiful polish being given by means of a composition of a red pigment and oil. They are then "set" (the settings all coming from Birmingham), and taken to the warehouse, where they are carded, or strung if necessary, and priced and packed by young women, being then stored for the inspection of the buyers.

Each process takes place in a separate room or department, and the magnitude of the whole concern may be guessed from the fact that Mr. C. B. employs 120 workpeople. He has lately constructed new premises, containing every improvement that experience could suggest, with accommodation for 170.

Mr. C. B. has taken prizes at most of the great exhibitions, and such is the fineness of his work that, according to the "Daily Telegraph's" report, the committee of last year's International Exhibition for some time expressed grave doubts—to be dispelled with ample apology—as to the reality and genuineness of the substance. The goods when stored are sold either by means of his four travellers, who visit all parts of the United Kingdom, by connections already established, or to buyers and shippers who visit Whitby at regular intervals. The wholesale

price is only about 50 per cent. of the retail. In addition to his large manufactory, Mr. C. B. has various shops in Whitby, and branch establishments in London, Birmingham, Brighton, Scarborough, Redcar, &c.

Nearly an eleventh of the total population of Whitby are engaged in this jet trade, for the workpeople number, according to the best authorities, from 1,350 to 1,400. The lads are taken on as apprentices for generally five years, at a wage of ten, twelve, fourteen, sixteen and eighteen shillings per week successively. After that they are able workmen, and earn from thirty shillings to three pounds, and even three pounds ten per week. The craftsmen are a very respectable and intelligent class, and the calling generally runs in families. A disciple of Mr. Darwin might derive some profit and pleasure in examining into the cause of the prevalent black colour in the costume of the natives, especially of the feminine portion, and in tracing it to the indirect influence of one prevailing artistic example and of one absorbing idea.

For the benefit of outsiders, we may state that the quality of the jet is readily determined by the fineness of its workmanship, soft jet (Spanish jet) being mainly confined to rough brooches and to round beads; but to experts, the touch, nay, the very smell, of the material betrays its crude value, quite apart from the labour spent upon the manufacture.

A few years since, Mr. Thompson, then member for the borough, desirous of encouraging the native industry, instituted annual exhibitions, and offered rewards to the workmen themselves for the best artistic examples of their craft. And these exhibitions, and the emulation they excited, served not a little to promote the interests of the town.

When in every street we saunter through, and in every ballroom to which the fates may take us, we cannot fail to see specimens of this workmanship, it is idle to deny the importance of so peculiarly artistic an industry. But to the good town of Whitby itself the whole trade becomes of great monetary moment, and we cannot marvel at it when we learn that the turn-over in manufactured jet last year exceeded £100,000 sterling.

The London and Birmingham jet trade is carried on by some half-dozen wholesale houses, who buy their goods direct from Whitby and sell them through their travellers to the various shops in town and country. One eminent London firm, Messrs. S. and S., whose exhibited case attracted so much professional attention at last year's International, have in addition a workshop of their own in town where their own special patterns are manufactured—being the only establishment out of Whitby who venture to rival products that seem almost indigenous to the quaint little town. At Birmingham a large trade has within the last ten years been established in imitation jet ornaments made variously from glass, papier mâché, shellac, and cannel-coal; but these, however cheap and attractive, have in no wise damaged the legitimate manufactures.

During the last twelvemonth goods of a much more expensive character have been made than were ever before attempted, in consequence of jet being worn not merely as an article for mourning, but also for evening wear by the fair sex generally, and the fashion seems still to be on the increase.

At Whitby, the manufacturers appear to think that their trade is capable still of a wide extension, but it would surely be well if they found fresh outlets for the goods stored in their teeming warehouses, for one and all confess that it is easier by far to produce than to sell. In the United States there is now a rapidly growing demand for jet, and it would probably be worth the while of some enterprising firm to establish a branch house at New York. In Bohemia too the ladies have a decided *penchant* for black; and though at present the rough Russian soft jet and imitation jet ornaments are in great request, it is only through the difficulty of obtaining the genuine Whitby article; for there is wealth and to spare in the country, and a great and abiding love for really artistic workmanship. It is a pity that no English manufacturer had the courage to send a case of jet to the Vienna Exhibition, for he would have at one and the same time sustained the reputation of the Whitby workmen, and have introduced his goods to the notice of a very powerful *clientèle*.

ON THE ILLUMINATING VALUE OF VEGETABLE, ANIMAL, AND MINERAL OILS, AND COAL GAS.

By Stevenson Macadam, F.R.S.E.

THIS communication has special reference to the light-giving power and relative cost of the illuminating agents in common use, and will include the results of a large number of experiments made upon the subject during the last ten years. Considering, however, that great fluctuations occur from time to time in the quality and cost of materials, every experiment has been recently repeated, and great additions have been made thereto.

The observations included common dip or tallow, composite, and paraffin candles; sperm, rape, and whale oils; paraffin and petroleum oils; and coal gas.

The illuminating standard of intensity of light was the sperm candle, burning 120 grains per hour; and the relative photogenic power of the flames, as contrasted with the said candle, was determined by Bunsen's photometer. The sperm candles were of the best quality, and burned generally between 120 and 122 grains per hour, and in no case was the trial considered as conclusive where the standard candle burned more than 125 or less than 117 grains per hour. The candle was weighed immediately before and after each experiment, and the requisite calculations were made to bring the light to the standard of 120 grains per hour. The room in which the experiments were conducted was kept at an uniform temperature of 60° F.

Considering that the various illuminating agents employed in these trials were of such different qualities and natures as candles, oils, and gas, sold and purchased respectively by the pound, gallon, and 1000 cubic feet, it appeared desirable, after determining the illuminating or photogenic power according to the pound, gallon, or cubic feet, that the light evolved in each case should be calculated into its equivalent in lbs. of sperm. Such a plan of recording the results enables the observer to see more clearly the relative illuminating power of the candles, oils, and gas. And, lastly, the photometric results were contrasted by calculating the light-giving value of each source of light yielded for a given price—say, a pennyworth of the material. In making the calculations, it was necessary to fix on a unit, and it was found best to take the standard sperm candle for one hour as *the unit of a candle hour*, and to reckon any light as equal to a given number of candle hours for 1d.—indicating that the light evolved was equivalent to that given by a standard sperm candle for the stated period.

Common Tallow or Dip Candles.—Three sizes of these candles were experimented upon, viz., 6, 8, and 12 to the lb., and the price was 6*d.* per lb., so that the respective candles cost 1*d.*, ¾*d.*, and ½*d.* each. The average weights of the candles were 1,118, 849, and 611 grains each. The size of the wicks was about the same in each sort, and, when burning, the candles lost in 1½ hours:—

1st, or largest size,	299 grains	and	giving an average of close upon 200 grains per hour.
2nd, or medium	297 „		
3rd, or smallest	300 „		

The consumpt of tallow, therefore, in each size of candle was practically the same, and the illuminating value of the light evolved from each was equal to 1·25 standard sperm candles burning during the hour. Calculating that if 200 grains of tallow consumed during the hour were equal to 1·25 candle or 150 grains of sperm burned during the same period, what would 1 lb. of the tallow candles be equal to? The following results were obtained:—

200 : 7000 :: 150 : 5250 grains of sperm;

or 1 lb. of tallow, consumed in common dip candles, evolves a light equal to that capable of being obtained from ·75 lbs. of sperm, burned in standard sperm candles of 120 grains per hour.

Composite Candles.—These candles were obtained in three sizes, viz., 4, 6, and 8 to the lb., and respectively weighing 1,758, 1,165, and 851 grains each on the average. The price was 8*d.* per lb., so that each candle cost respectively 2*d.*, 1½*d.*, and 1*d.* During burning for 1½ hours, the loss in weight was as follows:—

1st, or largest size,	260 grains		Average consumpt per hour, 154 grains.
2nd, or medium	232 „		
3rd, or smallest	199 „		

The light evolved during the combustion of the composite candles was in accordance with the relative consumpt, and the average illuminating power was equal to 1·1 standard sperm

candle, or 132 grains of sperm. Calculating these figures into 1 lb. of composite candles, and its equivalent in sperm, we obtain the following results :—

154 : 7000 : : 132 : 6000 grains of sperm ;

or 1 lb. of composite candles yields a light which is equivalent to that evolved from ·85 lb. of sperm consumed in standard sperm candles.

Paraffin Candles.—These candles were also in three sizes, viz., 6, 8, and 12 to the lb., and cost 1*s.* per lb., so that the price of each candle was respectively 2*d.*, 1½*d.*, and 1*d.*, whilst the average weight of each size was 1,117, 848, and 567 grains. The loss in weight during 1½ hours consumpt was as follows :—

1st, or largest size,	215 grains	}	Being an average consumpt of 137 grains per hour.
2nd, or medium „	206 „		
3rd, or smallest „	195 „		

The light evolved during the combustion of these candles was greater than that given by the tallow and composite candles, being equal to 1·494 standard sperm candles, or 179·28 grains of sperm. This result, calculated into lbs. of paraffin and sperm, gives the following :—

137 : 7000 : : 179·28 : 9160 grains of sperm ;

or 1 lb. of paraffin burned in candles evolves a light equal to that capable of being yielded by 1·3083 lbs. of sperm when consumed in standard sperm candles.[1]

These experimental results on the candles may be shortly stated thus :—

1 lb. of tallow candles is equal in light-giving power to—

			·75	lb.	of sperm candles.
1 lb. of composite	„	„	·85	„	„
1 lb. of paraffin	„	„	1·3083	„	„

Considering, however, the relative cost of the tallow, composite, and paraffin candles, it follows that, value for value, these results require to be amended according to the purchase price of the materials. A lb. or 7000 grains of the standard sperm candle, consuming 120 grains per hour, will necessarily give—

120)7000(58·33 candle hours.

One lb. of tallow candles is equal to ·75 lb. of sperm, and costs 6*d.*, hence—

1·00 : ·75 :: 58·33 : 43·74 candle hours from 1 lb.
6*d.*) 43·74

7·29 candle hours for 1*d.*

One lb. of composite candles is equivalent to ·85 lb. of sperm, and costs 8*d.*, therefore—

1·00 : ·85 :: 58·33 : 49·58 candle hours from 1 lb.
8*d.*) 49·58

6·19 candle hours for 1*d.*

One lb. of paraffin candles, costing 1*s.*, is equal to 1·3083 lb. of sperm, hence—

1·00 : 1·31 : : 58·33 : 76·41 candle hours from 1 lb.
12*d.*) 76·41

6·36 candle hours for 1*d.*

Sperm, Rape, and Whale Oils.—These oils were burned in two kinds of lamps, viz., 1st, a common flat-wick lamp, such as is used in kitchens and country cottages ; and 2nd, an inch Argand lamp with glass chimney, such as is employed in larger rooms. The oils were of excellent quality of their class, and cost at retail prices, sperm oil, 9*s.* per gallon ; colza or rape oil, 5*s.* per gallon ; and whale oil, 4*s.* per gallon.

Sperm Oil in Flat-Wick Lamps.—The consumpt of oil in 10 hours was 4·12 oz., which gives ·412 oz. per hour ; and the average light evolved was equal to 1·306 of standard sperm candles, or 156·72 grains of sperm. Calculating these results into one gallon of the sperm oil, viz., 160 oz., the following results were obtained :—

·412 : 160·000 : : 156·72 : 60,861 grains of sperm ;

or one gallon of sperm oil, consumed in the flat-wick lamp, is equal to 60,861 grains (8·69 lbs.) of sperm candles burned each at the rate of 120 grains per hour.

Rape Oil in Flat-Wick Lamps.—In 10 hours 3·90 oz. of oil were consumed, and this quantity is equal to ·39 oz. per hour. The light yielded was equal to 1·05 standard sperm candles, or 126 grains of sperm. Carrying on these calculations to the gallon of rape oil, we get as follows :—

·39 : 160·00 : : 126 : 51,693 grains of sperm ;

or one gallon of the rape oil, burned in the flat-wick lamp, evolves a light equal to that yielded by 51,693 grains (7·39 lbs.) of sperm consumed in standard sperm candles.

Whale Oil in Flat-Wick Lamp.—This oil burned at the rate of 3·50 oz. in 10 hours, which gives the hourly consumpt as ·35 oz. The light was equal to ·9 standard sperm candles, or 108 grains of sperm, and calculating this into the gallon of oil,

·35 : 160·00 : : 108 : 49,371 grains of sperm ;

or one gallon of the whale oil, consumed in the flat-wick lamp, is equal to 49,371 grains (7·05 lbs.) of sperm burned in standard sperm candles.

Sperm Oil in Argand Lamps.—The quantity of oil consumed in the Argand lamps was 2·30 oz. per hour, being fully five times the amount capable of being burned in the flat-wick lamp. The light evolved was equal to 13 standard sperm candles, or 1,560 grains of sperm consumed during the hour. Calculating into the gallon of oil, the following results were obtained :—

2·3 : 160·0 : : 1,560 : 108,522 grains, or 15·5 lbs. of sperm.

The great increase in light when the sperm oil is consumed in Argand lamps, as compared with that obtained when the same oil is burned in flat-wick lamps, is due to the greater body of oil which is consumed at the same time, and the consequent larger flame yielded by the oil, which enable the oil gas to resist more completely the deleterious effects of the oxygen of the air in intermingling with, and attenuating down, the luminosity of the flame. The practical result is, therefore, that the greater the body of oil which can be consumed in a lamp at one and the same time, the higher the illuminating power which is obtained from a given volume of the oil. The same observation applies to other oils, such as rape and whale oils. These remarks will explain why it is that a gallon of sperm oil, weighing less than 9 lbs., can evolve a light in the Argand lamp, which is equal to that given by 15¼ lbs. of sperm burned in candles consuming each only 120 grains per hour. The sperm oil is burning at the rate of 2·3 oz., whilst the standard candle is only consuming 120 grains, or slightly more than ¼ oz. of sperm per hour.

Rape Oil in Argand Lamps.—The consumpt of oil was 2·133 oz. per hour, and the light evolved was equal to 11·33 standard sperm candles, or 1,360 grains, which, when calculated into the gallon of the oil, gave

2·133 : 160·000 : : 1,360 : 102,016 grains, or 14·57 lbs. of sperm.

Whale Oil in Argand Lamps.—This oil burned at the rate of 1·95 oz. per hour, and yielded the light of 9·8 standard sperm candles, or 1,176 grains of sperm, and the results, calculated for the gallon of whale oil, yielded

1·95 : 160·00 : : 1,176 : 96,492 grains, or 12·69 lbs. of sperm.

The photogenic results of the combustion of the fatty oils in flat-wick and Argand lamps may be contrasted as follows :—

Flat-Wick Lamps.

1 gallon of sperm oil is equal in light-giving power to—

			8·69	lbs.	of sperm candles.
1 „	rape	„ „	7·39	„	„ „
1 „	whale	„ „	7·05	„	„ „

Argand Lamps.

1 gallon of sperm oil is equal in light-giving power to—

			15·5	lbs.	of sperm candles.
1 „	rape	„ „	14·57	„	„ „
1 „	whale	„ „	12·69	„	„ „

These results may be calculated for the price of oil as well as for the quantity consumed, and may, as in the case of the candles, be reduced to the common standard of candle units for 1*d.*

Flat-Wick Lamps.

A gallon of sperm oil costs 9*s.*, and evolves a light equal to 8·69 lbs. of sperm ; and each lb. of sperm candles, burning at the standard rate of 120 grains per hour for each candle, gives 58·33 candle hours ; consequently,

Sperm Oil at 9*s.* per gallon.

$$\frac{58{\cdot}33 \times 8{\cdot}69}{108} = 4{\cdot}69 \text{ candle hours for } 1d.$$

A gallon of rape oil = 7·39 lbs. of sperm candles ; therefore,

Rape Oil at 5*s.* per gallon.

$$\frac{58{\cdot}33 \times 7{\cdot}39}{60} = 7{\cdot}18 \text{ candle hours for } 1d.$$

[1] This amount of light yielded by solid paraffin in candles is theoretically much less than what ought to be obtained from the paraffin, and indicates that there is great room for improvement either in the manufacture or mode of combustion of these candles.

A gallon of whale = 7·05 lbs. of sperm oil candles; therefore,

Whale Oil at 4*s.* per gallon.

$$\frac{58{\cdot}33 \times 7{\cdot}05}{48} = 8{\cdot}56 \text{ candle hours for } 1d.$$

Argand Lamps.

A gallon of sperm oil = 15·5 lbs. of sperm candles; therefore,

Sperm Oil at 9*s.* per gallon.

$$\frac{58{\cdot}33 \times 15{\cdot}5}{108} = 8{\cdot}99 \text{ candle hours for } 1d.$$

A gallon of rape oil = 14·57 lbs. of sperm candles; therefore,

Rape Oil at 5*s.* per gallon.

$$\frac{58{\cdot}33 \times 14{\cdot}57}{60} = 14{\cdot}17 \text{ candle hours for } 1d.$$

A gallon of whale oil = 12·69 lbs. of sperm candles; therefore,

Whale Oil at 4*s.* per gallon.

$$\frac{58{\cdot}33 \times 12{\cdot}69}{48} = 15{\cdot}42 \text{ candle hours for } 1d.$$

The following table will show at a glance the respective cost of the candles and the fatty oils, and the relative value of the light obtainable from a given price of each.

Tallow candles give a light equal to	7·29	candle hours for	1*d.*		
Composite	„	„	6·19	„	1*d.*
Paraffin	„	„	6·36	„	1*d.*

Flat-Wick Lamps.

Sperm oil gives a light equal to	4·69	candle hours for	1*d.*		
Rape „	„	„	7·18	„	1*d.*
Whale „	„	„	8·56	„	1*d.*

Argand Lamps.

Sperm oil gives a light equal to	8·99	candle hours for	1*d.*		
Rape „	„	„	14·17	„	1*d.*
Whale „	„	„	15·42	„	1*d.*

Paraffin Oil.—Five different lamps were employed in the experiments upon the illuminating power of paraffin oil, viz.:—

Small sized flat-wick or cottage lamps.
Medium „ parlour lamps.
Large „ dining-room lamps.
Small Argand lamp with ¾-inch wick, and
Doty's Argand lamp with 1-inch wick.

The oils employed were manufactured by the Uphall Mineral Oil Company, and Young's Paraffin Oil Company, and were of excellent quality. The retail price was 2*s.* per gallon.

Small or Cottage Lamp.—The consumpt of oil in this lamp was ¾ oz. per hour, and the light evolved was equal to 6 standard sperm candles of 120 grains per hour, or 720 grains of sperm, which, calculated into the gallon of the paraffin oil, viz., 160 oz., gave the following results:—

·75 : 160·00 :: 720 : 153,600 grains, or 21·943 lbs. of sperm.

Medium or Parlour Lamp.—Consumed 1½ oz. of paraffin oil per hour, and yielded a light equal to 9 standard sperm candles, or 1,080 grains of sperm; consequently, the photogenic value of one gallon of the oil was,

1·125 : 160·000 :: 1,080 : 153,600 grains, or 21·943 lbs. of sperm.

Large or Dining-room Lamp.—Burned 1¼ oz. of paraffin oil per hour, with the illuminating value of 12 standard sperm candles, or 1,440 grains of sperm, so that the gallon of oil was equal to

1·5 : 160·0 :: 1,440 : 153,600 grains, or 21·943 lbs. of sperm.

Small Argand Lamp.—Consumed 1⅛ oz. of paraffin oil every hour, and the illuminating power of the light evolved was equal to that obtained from 9 standard sperm candles, or 1,080 grains of sperm, which, calculated into the gallon of oil, gave as follows:—

1·125 : 160·000 :: 1,080 : 153,600 grains, or 21·943 lbs. of sperm.

Doty's Argand Lamp.—Burned a little more than 2 oz. (2·004) of paraffin oil per hour, and yielded a light equal to 19·83 standard sperm candles, or 2,380 grains of sperm, which, when calculated for the gallon of oil, gave the following results:—

2·004 : 160·000 : : 2,380 : 190,400 grains, or 27·2 lbs. of sperm.

The foregoing experimental observations demonstrate that the paraffin oil, when consumed in any of the flat-wick lamps, or in the small Argand lamps, evolves the same amount of light from the gallon of the oil; and in this respect the paraffin oil differs materially from the vegetable and animal oils, which, as noticed previously, evolve proportionally more light when they are consumed in larger lamps, and in greater quantities at a time. On the other hand, the paraffin oil, when burned in the cottage lamp with a 6-candle power, yields as much light from the gallon as when consumed in larger lamps with a 9 or 12-candle power,—in other words, two 6-candle power paraffin lamps are equal in light-giving power to one 12-candle power lamp, and will consume exactly the same quantity of oil. The same remark applies to the small Argand lamp, which burns with a 9-candle power, and where for the consumpt of oil the light obtained from a given volume of the oil is neither greater nor less than what is yielded from any of the sizes of flat-wick lamps. Employing, therefore, any of the common constructions or sizes of paraffin lamps, the oil evolves a light strictly proportionate to the amount of oil consumed at the time.

The Doty lamp, however, from the superiority of its construction, and the more perfect combustion of the oil, yields a higher photogenic value from the paraffin oil, in the proportion of 27½ lbs. of sperm to 22 lbs. obtained as equivalent of light in the more common lamps.

The experimental results yielded by paraffin oil may be more readily contrasted with those obtained from candles and the animal and vegetable oils, by reducing the light evolved to the common standard of candle units for 1*d.*, and which was adopted in the previous parts of this paper. Thus—

A gallon of the paraffin oil consumed in the cottage, parlour, or dining-room flat wick lamps, or in the small Argand lamp, yields a light equal to that capable of being obtained from 21·943 lbs. of sperm burned in standard candles at the rate of 120 grains per hour; and as each lb. of sperm candles gives 58·33 candle hours or units, it follows that the ordinary lamps yield—

Paraffin Oil at 2*s.* per gallon.

$$\frac{58{\cdot}33 \times 21{\cdot}943}{24} = 53{\cdot}33 \text{ candle hours for } 1d.$$

whilst if the paraffin oil is purchased at 1*s.* 6*d.* per gallon,

Paraffin Oil at 1*s.* 6*d.* per gallon.

$$\frac{58{\cdot}33 \times 21{\cdot}943}{18} = 71{\cdot}11 \text{ candle hours for } 1d.$$

When the results in the Doty lamps are worked out in the same way, it is found that—

Paraffin Oil at 2*s.* per gallon.

$$\frac{58{\cdot}33 \times 27{\cdot}2}{24} = 66{\cdot}10 \text{ candle hours for } 1d.$$

And when paraffin oil may be purchased at 1*s.* 6*d.* per gallon the Doty results yield—

Paraffin Oil at 1*s.* 6*d.* per gallon.

$$\frac{58{\cdot}33 \times 27{\cdot}2}{18} = 88{\cdot}13 \text{ candle hours for } 1d.$$

The foregoing results show at once the great superiority and relative cheapness of paraffin oil as an illuminating agent over any vegetable or animal oils or fats consumed in candles or in lamps. The highest photogenic value obtainable from candles was from the common dip or tallow, which gave 7·29 candle hours for 1*d.*, and the greatest illuminating power of the oils, considering the cost, was given by whale oil, which yielded 8·56 candle hours for 1*d.*, when consumed in common lamps, and 15·42 candle hours for 1*d.*, when burned in the best Argand lamps. With paraffin oil, however, even when consumed in the common flat-wick lamps, there is a return of 53·33 candle hours for 1*d.*; and when burned in the Doty lamp, 66·10 candle hours for 1*d.*—the oil being taken at 2*s.* per gallon, or 71·11 candle hours for 1*d.*, and 88·13 candle hours for 1*d.* when the oil is 1*s.* 6*d.* per gallon. But reckoning the paraffin oil at the higher price, there is a sudden passage from candles giving 7¼ candle hours for 1*d.*, and fatty oils giving in common lamps 8½ candle hours for 1*d.*, or in improved Argand lamps 15½ candle hours for 1*d.*, to paraffin oil in common lamps yielding 53⅓ candle hours for 1*d.*, and in Doty's improved lamp 66 candle hours for 1*d.* Paraffin oil, therefore, is from four to eight times cheaper as an illuminating agent than any of the candles or vegetable and animal oils employed for light-giving purposes.

Petroleum Oil.—Experiments were made with petroleum oil in the flat-wick, Argand, and Doty lamps, and the results, taking cost into consideration, were on the average one-twelfth less than those yielded by paraffin oil.

Coal Gas.—In fixing the illuminating value and cost of the coal gas, the comparatively low average price of 5*s.* per 1000

cubic feet was taken, and the photogenic power of the gas was based upon 28 standard sperm candles. There are many places where the price of the gas is higher than 5*s.*, and some towns where it is lower; and there are few towns where the standard of 28 candles is exceeded, whilst in the majority of towns it is less. The adoption of the standard of 28-candle gas at 5*s.* per 1000 cubic feet, is within rather than above the average cost of gas.

Knowing well that the form and size of burner employed in the consumption of the gas had a most material bearing upon the illuminating or photogenic power of such, it was arranged that all the trials should be made with the union or fish-tail burner (which yields a higher photogenic return with 28-candle gas, than any other form of burner), whilst the sizes of the burners were Nos. 5, 4, 3, 2, 1, and 0·5. Care was taken to regulate the pressure, so that each burner should consume as nearly as possible the exact amount of gas in cubic feet, which the respective number indicated. Thus, No. 5 burner passed 5 cubic feet, No. 4 consumed 4 cubic feet, &c. The following short table gives the experimental results obtained in these trials :—

Jet.	Consumpt of gas per hour.	Evolved light equal to
No. 5, . .	5 cubic feet.	28 standard sperm candles.
No. 4, . .	4 „	20·8 „ „
No. 3, . .	3 „	13·8 „ „
No. 2, . .	2 „	7·8 „ „
No. 1, . .	1 „	3 „ „
No. 0·5, . .	½ „	1 „ „

In glancing at these results, there is manifestly a great loss of light as the size of the jet is diminished, and probably the difference will be better observed if the data given above be calculated into the light in standard sperm candles, capable of being obtained from a given volume—say, 5 cubic feet—of the gas transmitted through the various sized burners. Thus, 5 cubic feet of gas consumed at a

No. 5 jet evolves a light equal to 28 standard sperm candles.

No. 4	„	„	26	„	„
No. 3	„	„	23	„	„
No. 2	„	„	19½	„	„
No. 1	„	„	15	„	„
No. 0·5	„	„	10	„	„

So that we lose 2 candles going from No. 5 to No. 4, or one-fourteenth of the whole light; and between No. 5 and No. 2, there is a loss of one-third of the illuminating power; whilst between No. 5 and No. 0·5, there is a disappearance of nearly two-thirds of the whole light.

The results given were the best which could be obtained during the consumption of the 28-candle gas in the various jets, with well-regulated pressure, and they are higher than those given in other trials, where the pressure was purposely allowed to be excessive. Indeed, the loss in illuminating power when the gas is burned with undue pressure is large, and may be observed from the following experimental data, calculated for 5 cubic feet of gas.

Fish-tail or union jet.	Under full pressure. Consumpt in cubic feet.	Under full pressure. Candle-power for 5 cubic feet.	Under reduced pressure. Consumpt in cubic feet.	Under reduced pressure. Candle-power for 5 cubic feet.
No. 5 . .	4·99	28·14	4·99	28·14
„ 4 . .	4·94	24·02	4	25·98
„ 3 . .	4·36	20·48	3	22·89
„ 2 . .	3·14	15·16	2	19·46
„ 1 . .	2·49	10·94	1	14·95
„ 0·5 . .	1·68	7·04	0·5	10·12

It will thus be observed that there is a serious loss of illuminating power when the gas is consumed under undue pressure; there being in the case of No. 2 burner, which is the more common size used in households, a difference of fully 4-candle power between the light obtained from 5 cubic feet burned at the proper pressure, and that given under excessive pressure.

Taking, however, the best results obtained from the 28-candle coal-gas during its combustion from the various sized jets under proper pressures, and calculating the light evolved from such jet, for every 5 cubic feet consumed, into standard candle hours or units for 1*d.*, the following results are obtained :—

No. 5 *jet* consumes 5 cubic feet per hour, and evolves a light equal to 28-standard sperm candles; consequently the gas, in being burned from this jet, gives—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
28

60)5600

93·33 candle hours for 1*d.*

No. 4 *jet* consumes 4 cubic feet per hour, and gives a light equal to 26-standard sperm candles for every 5 cubic feet consumed; consequently—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
26

60)5200

86·66 candle hours for 1*d.*

No. 3 *jet* burns 3 cubic feet per hour, and yields a light equal to 23-candle power for every 5 cubic feet consumed; therefore—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
23

60)4600

76·66 candle hours for 1*d.*

No. 2 *jet* consumes 2 cubic feet of gas, and evolves a light equal to 19½-standard sperm candles for every 5 cubic feet burned; hence—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
19½

60)3900

65 candle hours for 1*d.*

No. 1 *jet* burns 1 cubic foot per hour, with the photogenic power of 15-standard sperm candles for every 5 cubic feet consumed; therefore—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
15

60)3000

50 candle hours for 1*d.*

No. 0·5 *jet*, with a consumpt of half a cubic foot per hour, evolves a light equal to 10-candle power for every 5 cubic feet; consequently—

Coal Gas, at 5*s.* per 1,000 cubic feet.

5)1000

200
10

60)2000

33·33 candle hours for 1*d.*

These results may be tabulated as follows:—

For every 5 cubic feet of Gas consumed.

No. 5	jet gives a light equal to	93·33	candle hours for	1*d.*
„ 4	„	„	86·66	„	„ 1*d.*
„ 3	„	„	76·66	„	„ 1*d.*
„ 2	„	„	65	„	„ 1*d.*
„ 1	„	„	50	„	„ 1*d.*
„ 0·5	„	„	33·33	„	„ 1*d.*

The foregoing experimental data prove that where much light is required, coal gas is the cheapest of all the illuminants, provided the gas can be obtained of the quality of 28 candles, and at a cost not exceeding 5*s.* per 1,000 cubic feet, and is burned from the larger sized jets. Under these circumstances, and paraffin oil at 2*s.* per gallon, the gas gives 93⅓ candle hours in No. 5 jet, 81⅔ candle hours in No. 4 jet, and 76⅔ candle hours or units in No. 3 jet; whilst the paraffin oil in Doty's lamp yields 66 candle hours or units for the 1*d.*; but the gas only gives 65 candle hours in No. 2 jet, 50 candle hours in No. 1 jet, and 33⅓ candle hours in No. 0·5 jet for the 1*d.* Consequently, whilst the gas is a cheaper illuminating agent in the three larger sized burners or jets, the paraffin oil is cheaper when the gas is consumed in the three smaller jets.

Summary of Results.

The following table will exhibit at a glance the relative illuminating power and photogenic value of the different luminants, taking each as they were burned :—

½*d.* dip or tallow candle gives	3	hours of	1¼	candle power for	½*d.*
¾*d.*	„	„	„	4½	„	1¼	„	„	¾*d.*
1*d.*	„	„	„	6	„	1¼	„	„	1*d.*
Composite candle (average)	„	5½	„	1·1	„	„	1*d.*
Paraffin candle (average)	„	4·27	„	1·49	„	„	1*d.*

Common Flat-Wick Lamps.

Sperm oil gives	3·59	hours of	1·306	candle power for	1*d.*
Rape oil	„	6·84	„	1·05	„	„	1*d.*
Whale oil	„	9·5	„	·9	„	„	1*d.*

Argand Lamps.

Sperm oil gives	·69	hours of	13	candle power for	1*d.*
Rape oil	„	1·25	„	11·33	„	„	1*d.*
Whale oil	„	1·57	„	9·8	„	„	1*d.*

Cottage Lamp.

Paraffin oil, at 2*s.* per gallon, gives 9 hours of 6-candle power for 1*d.*

Parlour Lamp.

Paraffin oil, at 2*s.* per gallon, gives 6 hours of 9-candle power for 1*d.*

Dining-Room Lamp.

Paraffin oil, at 2*s.* per gallon, gives 4½ hours of 12-candle power for 1*d.*

½-inch Argand Lamp.

Paraffin oil, at 2*s.* per gallon, gives 6 hours of 9-candle power for 1*d.*

Doty's Lamp.

Paraffin oil, at 2*s.* per gallon, gives 6 hours of 11⅓-candle power for 1*d.*

No. 5 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 3⅓ hours of 28-candle power for 1*d.*

No. 4 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 4·16 hours of 20·8-candle power for 1*d.*

No. 3 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 5·55 hours of 13·8-candle power for 1*d.*

No. 2 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 8·33 hours of 7·8-candle power for 1*d.*

No. 1 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 16·66 hours of 3-candle power for 1*d.*

No. 0·5 Jet.

28-candle gas, at 5*s.* per 1,000 cubic feet, gives 33⅓ hours of 1-candle power for 1*d.*

Cottage Lamp.

Paraffin oil, at 1*s.* 6*d.* per gallon, gives 12 hours of 6-candle power for 1*d.*

Parlour Lamp.

Paraffin oil, at 1*s.* 6*d.* per gallon, gives 8 hours of 9-candle power for 1*d.*

Dining-Room Lamp.

Paraffin oil, at 1*s.* 6*d.* per gallon, gives 6 hours of 12-candle power for 1*d.*

¾-inch Argand Lamp.

Paraffin oil, at 1*s.* 6*d.* per gallon, gives 8 hours of 9-candle power for 1*d.*

Doty's Lamp.

Paraffin oil, at 1*s.* 6*d.* per gallon, gives 8 hours of 11⅓-candle power for 1*d.*

From the foregoing table it follows that a cottager will consume a 1*d.* tallow candle in 6 hours, and will only get 1¼-candle power of light ; whilst, if he purchases paraffin oil at 2*s.* per gallon, he will obtain, for every pennyworth of paraffin oil consumed in a common small lamp, 9 hours light of 6 candle-power. The most economical of candles, therefore, is beat by paraffin oil so completely, that the latter will burn half as long again a time and give nearly five times the amount of light during the whole period. A similar remark applies to whale oil, which is the most economical fatty oil, and a pennyworth of which will burn for 9½ hours with less than a candle power, whilst the small paraffin lamp will practically burn as long and give six times the light for the same sum of money. Not only so, but if the cottager is content with the light of a single candle, and will reduce the size of the flame of the paraffin lamp by simply screwing down the wick, he may burn the paraffin oil with a single candle power, and spread his one pennyworth of oil over 54 hours, whereas his 1*d.* candle will burn out in 6 hours, and he cannot stop the rapidity of its combustion.

In contrasting the paraffin oil with coal gas, it will be found that paraffin oil is cheaper than gas in the No. 0·5 jet, as the following calculations will show :—

Paraffin cottage lamp,—9 hours of 6 candles, equal to reduced flame of 54 hours of 1 candle.	No. 0·5 jet coal gas gives 33⅓ hours of 1 candle.

The same remark applies to No 1 jet, where

Paraffin cottage lamp,—9 hours of 6 candles, equal to reduced flame of 18 hours of 3 candles.	No. 1 jet coal gas gives 16·66 hours of 3 candles.

When the gas is burned from No. 2 jet, and the paraffin oil is consumed in a common parlour lamp, the gas beats the paraffin, for

Paraffin parlour lamp,—6 hours of 9 candles, equal to reduced flame of 6·92 hours of 7·8 candles.	No. 2 jet coal gas gives 8·33 hours of 7·8 candles.

But when the paraffin oil is consumed in Doty's lamps the two luminants are practically equal, for

Paraffin Doty lamp,—6 hours of 11⅓ candles, equal to reduced flame of 8·71 hours of 7·8 candles.	No. 2 jet coal gas gives 8·33 hours of 7·8 candles.

With coal gas at 5*s.* per 1000 cubic feet and 28 candle power the gas is cheaper than paraffin oil when the gas is consumed in the No. 3 jet, but if the gas cost 5*s.* 8*d.* per 1000 cubic feet, the two illuminating agents are equal ; thus—

2 reduced Doty lamps will yield 4·92 hours of 13·8 candles.	No. 3 jet coal gas gives 5·55 hours of 13·8 candles (at 5*s.*), but 4·90 hours of 13·8 candles, when the gas costs 5*s.* 8*d.* per 1000 cubic feet.

The paraffin oil and gas from No. 4 jet only become equal when the gas costs 6*s.* 6*d.* per 1000 cubic feet ; thus—

2 reduced Doty lamps afford the light of 3·26 hours of 20·8 candles.	No. 4 jet coal gas gives 4·16 hours of 20·8 candles (at 5*s.*), but 3·20 hours of 20·8 candles when the gas costs 6*s.* 6*d.* per 1000 cubic feet.

The gas is superior to paraffin when the No. 5 jet is used, until the price of the gas reaches 7*s.* per 1000 cubic feet ; thus—

3 reduced Doty lamps afford the light of 2·42 hours of 28 candles.	No. 5 jet coal gas gives 3⅓ hours of 28 candles (at 5*s.*), but 3·28 hours of 28 candles when the gas costs 7*s.* per 1000 cubic feet.

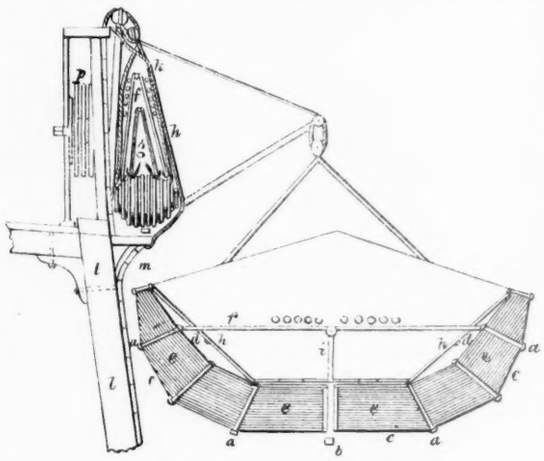
The above comparisons are drawn out on the basis of the photogenic value of the gas and paraffin oil for 1*d.*, and on the assumption that the coal gas is of 28 candle power when consumed at the rate of 5 cubic feet per hour from a No. 5 fishtail or union burner ; but in many places the gas does not come up to this standard, and granting that the gas can be purchased at 5*s.* per 1000 cubic feet, and the paraffin oil at 2*s.* per gallon, both luminants will still remain equal when the larger gas-jets are used, if the quality of the gas comes below 28 candles. Thus, paraffin oil is as cheap as gas, when the latter is consumed at No. 3 jet, if the gas costs 5*s.* per 1000 cubic feet, and is of 24·70 candle-power, or at No. 4 jet, when the same priced gas is of 21·53 candle-power, or at No. 5 jet, when the 5*s.* gas is of 20 candle power.

The great convenience attendant on the use of coal gas, and the trouble connected with oil lamps, must always commend the gas for general use, wherever it can be obtained at reasonable cost, but where the charge is exorbitant, the paraffin oil will be found useful and serviceable in the illumination of not only small but of large apartments.

These two luminants are not antagonistic to each other in their chemical construction, or in the economical and photogenic results obtained during their combustion; and considering that the refined paraffin oil, costing 2*s.* per gallon, becomes almost equal to gas when the ordinary sized jets are used, the question may be asked, if it be not possible to experiment with the crude paraffin oil in our gas retorts, so as to get cheap illuminating gas from it. Great difficulties are in the way of obtaining permanent gas from paraffin oil, but considering that crude paraffin oil can be purchased at a sixth of the price of the refined oil, it appears probable that if some method of destructive distillation could be devised and followed out, where the crude oil could be broken up into gas which would not condense in the gasometers or pipes, a great and important step would be taken in the advancement of the manufacture of coal gas. Cannel coals are not so cheap as they were, and the shale beds are of vast extent and extremely prolific of oil; so that it appears probable that the future of gas making will lie in the discovery of a practical process for transmitting crude shale oil into our gas retorts, and obtaining therefrom a permanent gas of high photogenic or illuminating power.

SAVING LIFE AT SEA.

THE fearful shipwrecks, most notably perhaps those of the "Northfleet" and "Atlantic," which have recently occurred, and been attended as well with immense loss of life as terrible sufferings to the survivors of the disasters,—have most naturally attracted attention as to what means the ingenuity of man has devised to enable him successfully to defend that dearest of all his possessions—life, from the dangers which, to a certain extent, are apparently inseparable from voyages by sea;



BERTHON'S COLLAPSING LIFE-BOAT.

and we are indebted, we believe, to the Committee of the Northfleet Relief Fund for having been the means of gathering together a collection, lately displayed at the London Tavern, and thereafter transferred in great measure to the Kensington Exhibition, of some of the best known and most valuable inventions which have been made towards that philanthropic end. To the readers of the "Practical Magazine" we need only say, to insure their taking even an unusual interest in this matter, that of many of these plans and propositions the inventors are men who have actually had to face the horrors of shipwreck in their grim reality—men to whom the ocean, with all its dangers, has been almost their only home, and who are thus, certainly in no small measure, able to judge from experience of the intrinsic value of their own and other people's plans; whilst, on the other hand, it will be seen that men of science and cultivation have employed much time and given much thought and consideration towards the mitigation of danger to those who "go down to the sea in ships." It would be beyond the scope of a magazine article to attempt a categorical description of the many different systems offered to the judgment of the public—hence we shall have to confine ourselves to those which more immediately attracted our attention, premising, however, that we do not in anywise wish it to be understood that those plans, passed over without mention, are considered by us to be devoid of usefulness or practical applicability.

One of the first models which we noticed was that of Berthon's Patent Collapsing Life-boat, the invention, we understand, of the Rev. E. L. Berthon, of Fareham, of which we give a cut representing the boat in section, both open and collapsed, together with a gunwale plan, showing the boat when fully expanded and ready to receive passengers and crew.

Of the section appended and of its mechanical construction the following is a description in detail:—

a. a. a. &c. are the timbers.
b. the keel.
c. c. c. &c. the outer skin.
d. d. d. &c. the inner skin.
e. e. e. &c. the air cells.
f. the thwarts.
g. the bottom boards.
h. h. the gunwale-stanchions.

The part of the woodcut on the left side shows the same boat collapsed; the thwarts (with oars attached), and the bottom boards are here shown standing up folded at an acute angle; the folds of the skins are doubled inwards.

l. l. is part of the ship's side in section.

m. is a small projection.

n. is a strong flap, attached by its lower edge to the projection *m*.

The davits are here shown nearly vertical. Inside the bulwarks is a large flat drum *p*, round which, in separate scores, the falls of the tackles are wound; a friction strap and lever are so applied to this drum, that the boat can be lowered with the greatest ease and certainty by one man slacking the lever; both falls must run off evenly, and no hitch can take place, as there are no slack ropes, or loose parts.

The framework is composed of Canada elm timbers, extending in a fore and aft direction, the whole length of the boat, two inches thick, and varying from about eight to eighteen inches in depth. These timbers are eight in number four on each side of the keel, and each timber is formed by cutting a thin Canada elm plank to the required shape, and strengthening it by four battens of the same material brought upon each of its sides, both on its upper and lower edges; which battens are firmly fastened to the plank by bolts and marine glue.

The gunwale is also composed of six thin Canada elm planks, glued and bolted together; and the timbers are jointed together at their ends, and fastened into one compact mass at the stem and stern post by a chain hinge.

A block of wood is placed between the ends of these timbers on each side of the stem and stern post; and the two sides of the boat are firmly connected together, forward and aft, by an iron bar, extending from gunwale to gunwale.

These diagonal timbers stand side by side in vertical planes when the boat is collapsed, and in radial planes when expanded; and, being properly shaped, this frame has been made to assume nearly the form of a common whale boat.

Over this frame are stretched two distinct skins, made of very strong durable waterproof materials, composed of prepared canvas, saturated with india-rubber, which are secured to the edges of the timbers, the outer skin to the outer edges, and the inner skin to the inner edges.

The whole body of the boat is by these means divided into eight tight longitudinal compartments, which are spontaneously filled with air at the moment when the boat is lowered, and expanded by its own weight falling on the gunwale spars, which action, causes the timbers to separate, and the air to rush in at the bow and stern, through apertures made for this purpose.

The extension of this boat is effected by the thwarts and bottom boards, which, being jointed in the middle, stand up at a very acute angle when the boat is collapsed, and fall down straight when it is open. These act as stretchers, and the more nearly they assume a straight line, the greater force they exert to maintain the boat in its permanent and proper shape. Two stretchers, hinged in the middle, are also fitted on each side of the boat, extending down the inside from the gunwale to the bottom boards, which act in a similar manner as the thwarts, and which thrust up the gunwale, and assist to maintain the whole frame in its required form and dimensions.

Its keel is 22 inches deep and 4½ inches thick amidships, and two bilge pieces are fitted on each side. The skins are covered over the edges of the timbers, and are protected by slips of copper, and the whole of the iron work is galvanised.

This boat is of the following principal dimensions, viz.:—

Length, over all	30 feet.
Breadth, extreme	10 „
Depth	4 feet 6 inches.

It has six thwarts, with head and stern sheets, and can pull twelve oars double banked.

From the small quantity of wood materials, &c., used in its construction, and the lightness of the outer and inner skins or coverings, its weight does not exceed 23 cwt., and the space which the boat occupies when collapsed, will not be more than two feet in width.

Independently of its form, its buoyancy is greatly increased by the air-tight compartments into which it is divided, which contain about 350 cubic feet of air, and which render the boat capable of carrying as many persons as could be stowed in it.

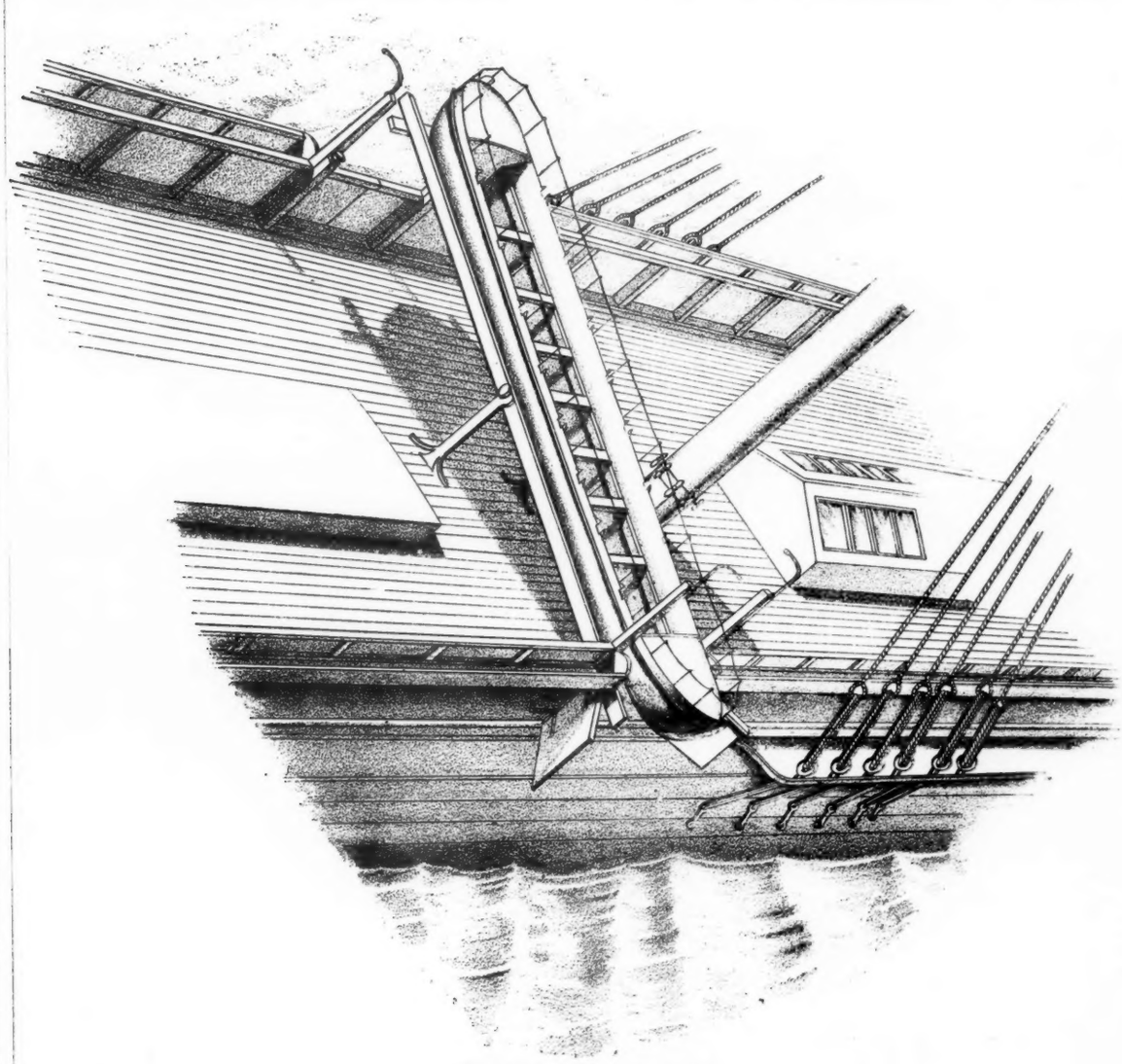
Its efficiency as a life-boat is further provided for by the contrivance of the keel being made in two pieces, longitudinally, so as to form a groove or water-course under the bottom boards, in which such water as may be "shipped" runs, and is discharged through the bottom by means of a valve opening outwards.

The most prominent of the advantages claimed by the inventor for the collapsing life-boat are that—

1. It can be stowed in one-sixth of its width.

2. When collapsed, it is frapped-to against the ship's bulwarks, being firmly secured there, and covered by a strong flap of double canvas, and thus, *being always outboard*, is ready at any moment.

3. A single hand is enough to open and lower the largest



WHITE'S LIFE BOAT BRIDGE.

boat; he can expand it easily in a few seconds, and lower it quickly or slowly, as may be thought best, whilst *it is sure to take the water on an even keel.*

4. From the large volume of air it takes up as it spontaneously expands, it becomes perfectly insubmergible.

5. It offers no temptation to terrified passengers, whose rush to boats on the davits has been so often fatal, there being in fact no boat visible until it is actually wanted, when a simple act developes it almost instantaneously.

To open and lower the boat, nothing more is necessary than to cast off the covering flap, which is made fast to the top rail; then raise the lever, and the boat falls out with its davits, and opens spontaneously; at the same moment the air rushes in through proper apertures; the thwarts, bottom boards, and stanchions drop into their places, and in a few seconds a perfect, strong, and efficient life-boat presents itself ready for lowering.

From the foregoing our readers will have gathered the principles on which this boat is constructed. They are certainly, so far as we know, quite novel, and we incline to think, thoroughly sound and correct, an opinion in which we are supported by the Assistant Master Shipwright and foreman superintending the boat-houses at Portsmouth Dockyard, who have reported most favourably on it, not only as a life-boat but as one admirably adapted for landing or embarking troops, artillery stores, &c. Mr. Berthon's collapsed boat is also most favourably mentioned in the "Journal (January, 1857) of the National Life-Boat Institution."

Amongst other inventions Mr. John White, Medina Docks,

Cowes, brings forward his life boat bridge, the principle of which will be readily understood from our illustration. The application is that of converting the bridges hitherto only used as a means of crossing from side to side of the ship into life boats, which can be launched without difficulty in an exceedingly short space of time, no tackle, mast or yards being required; and the inventor especially claims that, in their position athwartships, these boats are not so liable to be damaged or washed away as are those hung on davits outside the vessel. This boat is launched by knocking away the two stancheons, when it immediately tips and slips into the water, being thus far almost self-acting, a most desirable thing amidst the confusion and horrors of a shipwreck. It is not proposed to fill the bridge-boat with passengers in its place, but to launch it with a hawser attached, so that it may be veered clear of the ship and lie under the quarter out of danger; these boats are built upon the diagonal plan, and one 40 feet long by 10 feet in width would carry 125 souls, besides dead weight. Of course a plurality of these bridge-boats might be carried according to the size of the ship and number of passengers, and the watertight compartments on each side above the thwarts can be made to slip, and this quite independently of those underneath. We may recur to the subject.

MANUFACTURE OF ANILINE COLOURS.

AT THE WORKS OF M. A. POIRRIER, SAINT-DENIS.

(*Translated from "Les Grandes Usines" by M. Turgan.*)

IN our opinion, the difficulty in manufacturing aniline colours was to carry out on the large scale the discoveries made in the laboratory, which always appeared to us to be surrounded with difficulties enough—how to separate, combine, displace, and replace with facility the elements H, C, N, O, Ch, S, so as to form alcohols, essences, and finally the colouring matters themselves, rivalling those which Nature deposits in the petals of flowers or in the tissue of leaves.

In 1824 the manufacture of orchil, and of extract of orchil and cudbeard, was established by M. Jeannet in the rue Folie-Méricourt, Paris, of which Ch. Mottet became the principal in 1845. M. Mottet very soon rose to the first rank in this industry. He added the manufacture of carmine of indigo and of ammoniacal cochineal, and at the Exhibitions of 1851 and 1855 he obtained the prize medal and the medal of the first class. The works in the rue Folie-Méricourt became insufficient, and M. Mottet founded, in 1853, the works at Saint-Denis which form the subject of this article.

In 1858 M. Poirrier, a fellow-labourer of M. Mottet, succeeded to his business, with the younger Chappat as partner, until the end of 1868, when, at the decease of M. Chappat, M. Poirrier became sole proprietor of the works.

The partnership had scarcely commenced when there appeared a new violet colour, said to be extracted from aniline. This colour had a splendour previously unknown amongst the dyeing colours, though it was thought that it could never be employed on a manufacturing scale, on account of its high price. But MM. Poirrier and Chappat from the first foresaw that the future of colouring matters lay in their manufacture from coal-tar. They set to work at once, and were able to deliver, at a comparatively moderate price, the new violet colour, which they called rosolane. In 1861 they manufactured and sold more than £120,000 worth of this colour, which was sent to all parts of the world. They obtained the large medal of 1862 for this product.

The impulse was given; the manufacture of aniline colours made great progress; numerous patents were taken out for the manufacture of red, blue, and new violets. MM. Poirrier and Chappat renewed their efforts, and after some years of labour and research, with the assistance of able co-workers, they regained the first place among the manufacturers of aniline colours on the Continent by the discovery and the sale of the Paris violet (*violet de Paris*), for which they received a gold medal in 1867. In 1868 the *Société la Fuchsine*, which possessed or monopolised nearly all the French patents for the manufacture of red, violet, blue, and green from aniline, granted a licence for the manufacture of their patented colours to MM. Poirrier and Chappat, who had seen that this peculiarly French manufacture was about to pass into the hands of foreigners. They now manufacture about half a ton per day of the new colours, of which more than a third is exported.

M. Poirrier employs a staff of chemists, who act as heads of departments, with foremen under their orders. The Saint-Denis works cover an area of nearly 4½ acres, is connected by a line to the Northern Railway, and communicates with the Seine by a road. The service of the works is supplied by five boilers of 200 horse-power combined and five steam-engines of various powers. There are 200 workmen employed.

M. Poirrier continues to manufacture various colouring matters not derived from coal; but the present paper is to be occupied with the colours derived from aniline.

The manufacture of aniline colours originated at a comparatively recent date, in 1856. It is to Mr. Perkin, an English chemist, that the honour of the discovery of these colours is due. He sought to obtain an artificial quinine by the reaction of an oxidising agent upon sulphate of aniline; and he obtained a violet colour which he separated from a black mass of little interest. The cost of this new colouring matter was at first so high that few people believed in its great future. A pound of the dry matter was to be sold for about £70. The discoverer hesitated to commence the manufacture of the new colour; and he was anticipated by several French manufacturers; amongst others, by Poirrier and Chappat, who introduced some modifications of his process. There were great practical difficulties in the making of the new violet. Perkin's patent very well described the mode of obtaining violet by the reaction of bichromate of potass on sulphate of aniline. But though aniline was known to chemists who might possess a few grains of it in their laboratories, it was but little known to manufacturers. They referred to scientific works, and learned that the most advantageous mode of preparing aniline was by means of nitro-benzine. But this product was not manufactured any more than aniline. Benzine, until then, was very little used, except for removing stains from cloth; and it was known as benzine-collas.

Everything on a manufacturing scale had to be created for the production of aniline and nitro-benzine. Manufacturers applied to the gasworks for benzine, and obtained the tar, —a product with which the works were encumbered; thus creating a double benefit—to the gasworks and to themselves.

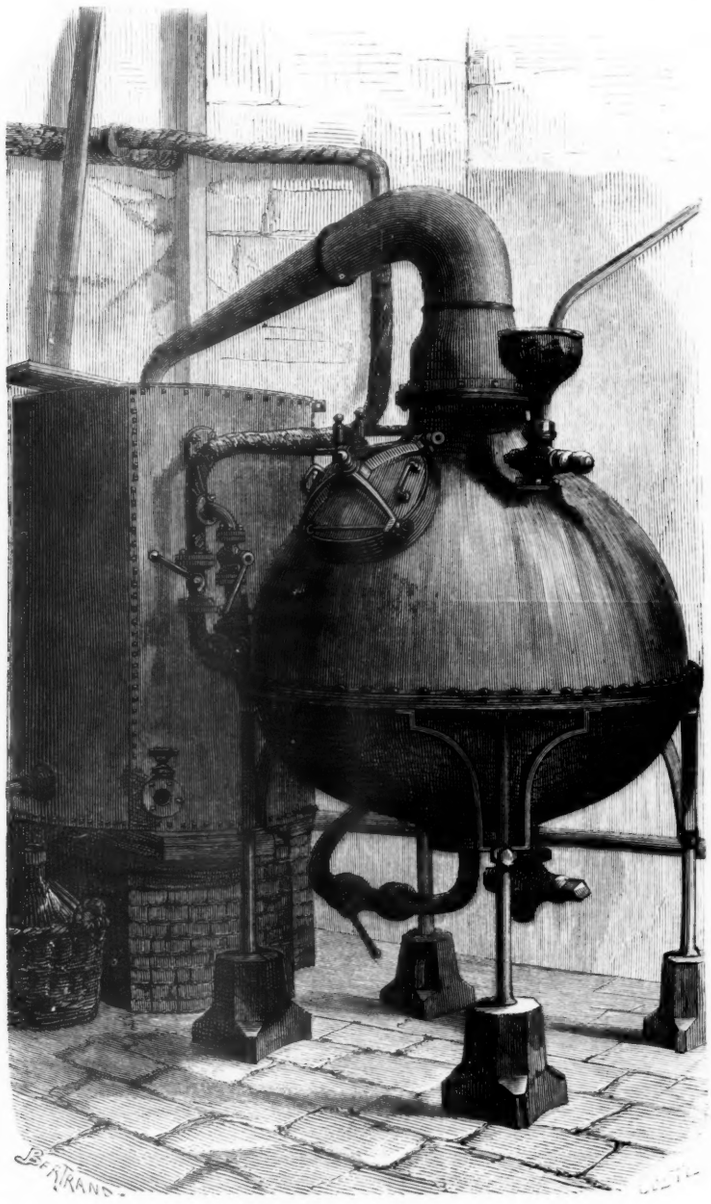
The English manufacturers, however, were the first to distil their tars. In less than three years the manufacture of aniline colours was thoroughly established on a large scale in France, England, and Germany, according to a process discovered by the French chemist Béchamp. It is the only practicable one amongst all those which have been proposed, and is that which is universally adopted by the aniline manufacturers. Aniline, which was scarcely known, and was produced at first at a cost of about 55*s.* per pound, fell rapidly in price to about nine shillings, and more recently to about elevenpence per pound.

From the day that aniline could be had for nine shillings a pound the future of aniline colours was assured. In 1859 M. Verguin, a manufacturing chemist of Lyons, commenced the manufacture of aniline red. This colour had been anticipated a few months earlier by M. Hofmann; but to M. Verguin belongs the merit of having originated the manufacture of it. He communicated his process and his product to MM. Renard Brothers, dyers at Lyons, who immediately patented both. The first appearance of red created no less a sensation than that of violet. Its price was very high, £22 per pound, for an article less pure than is now sold for £2. MM. Renard gave it the name of fuchsine, and nothing else could be seen but magentas everywhere, made from the new colour.

M. Verguin did not at first employ the best means for turning aniline to a red colour; and many others were soon discovered which yielded better results. All of them proceeded on the same principle—the diminution of hydrogen in the aniline, and the ultimate formation of a salt of a base of which Hofmann determined the composition some time afterwards, and to which he gave the name of rosaniline, with the formula $C^{20}\,H^{19}\,N^{3}\,H^{2}\,O$. These variations led to numerous actions at law, but the tribunals saw no novelty in the substitution of one agent for another, reacting on aniline for the purpose of arriving at the same product. They therefore accorded to MM. Renard the exclusive property in aniline red, which they were the first to manufacture and apply on a commercial scale.

From France, the manufacture of aniline red extended to England, Germany, and Switzerland; and, unlike that of aniline violet, which, though of English origin, very soon became a French manufacture, the manufacture of red, discovered in France, rapidly spread in Germany.

Aniline red served not only for dyeing in that magnificent colour, magenta, known to everybody, but it became the point of departure for the discovery and manufacture of all the other aniline colours: blue, violet, green, garnet, &c. Red had only been two years in existence as a manufacture, when two young French chemists, Girard and de Laire, found that it could be transformed into a violet more beautiful than Perkin's violet, and into a magnificent blue by heating it with aniline. They carried their process to MM. Renard, and the new blue at once



DISTILLING APPARATUS.

replaced, in the greater number of applications, the French blues and the carmine of indigo. About the same time, MM. Guinon, Marnas, and Bonnet manufactured a blue called azuline; but it gave way before the aniline blue.

Discovery continued to make progress; after blue followed green, derived from the original red, and discovered by M. Cherpin. He discovered it whilst endeavouring to fix a blue colour obtained by M. Lauth in the reaction of aldehyde upon the red, which was not permanent. By the advice of a photographer, his friend, who considered that the hyposulphite of soda was the universal fixer, he tried this salt for the purpose of fixing the aldehyde blue of M. Lauth, in the same manner as a photographic proof is fixed. He was surprised to find his blue transformed into a green, and a permanent green. This new green was at once employed by the dyers for dyeing silk, instead of the older greens. It was successfully printed on wool, though the attempts at dyeing wool in the new colours have not yet fully succeeded.

We have seen aniline red turned into violet, blue, and green. Hofmann made still another combination; he submitted the red to the action of an alcoholic radical, and obtained the magnificent violet which bears his name.

As Girard and de Laire obtained Imperial violet and blue by substituting a few molecules of the radical *phényle*, $C^6 H^5$, in aniline, for a few molecules of hydrogen in rosaniline, so Hofmann substituted the radicals of alcohols (ethyl, $C^2 H^5$, methyl, $C^1 H^3$, &c.) in the same rosaniline.

The Hofmann violet stood for a long time at 44*s.* per pound, and for that reason it was restricted in use. Then came the Paris violet, which was derived directly from aniline, without passing through the stage of red. It became very desirable to obtain such colours, which should be different in composition from those obtained with rosaniline, and which should rival them in brightness and cheapness. This problem was solved by MM. Poirrier and Chappat, with regard to Paris violet. This colour, the violet of methylaniline, had been

WORKSHOP FOR

FOR BLUES.

discovered in 1861 by Lauth; but for various reasons he did not follow up his discovery. It was in 1865 that MM. Poirrier and Chappat, with the assistance of their chemist, M. Bardy, commenced the manufacture of violet derived from aniline, to which a radical alcohol had previously been added. The greatest difficulty was experienced in manufacturing those alkaloids by a practical process, and at a price not greater than that of Hofmann's violet, for the processes then followed in the laboratory for obtaining ethylaniline and methylaniline by the reaction of alcoholic iodides was excessively costly and commercially impracticable. Here, however, practice borrowed from science. Berthelot's process for substituting an alcoholic radical in ammoniac, by heating, under pressure, alcohol with hydrochlorate of ammonia, was applied to aniline. The operation was both delicate and dangerous; it was necessary to have apparatus both strong enough to resist considerable pressure, and tight enough to prevent the escape of any gas. Until that time preparations in close vessels were scarcely known in industrial operations. Every precaution was taken, no accident happened, and, after much perseverance, labour and expense, the desired result was achieved. M. Poirrier produces daily about 660 pounds of methylaniline. This substance once obtained, it only remained to choose the agent most convenient for turning it into violet. There are several agents, but they do not all give good results. MM. Poirrier and Chappat effected the conversion by an original but costly process, when M. Lauth replaced it by a cheaper process, and thenceforth Paris violet could be delivered at a comparatively low price.

Paris violet gave shades identical with those of Hofmann, and it was sold at 36*s.* a pound, while Hofmann's cost double the money. Besides, Hofmann sold his colour in the condition of the hydriodate, which was insoluble in water, and was only soluble in alcohol, which considerably added to the cost; whereas the Paris violet was soluble in water. It is now preferred to Hofmann's violet for clearness and purity. It is not made anywhere else but at Poirrier and Chappat's works.

MM. Girard and de Laire have likewise discovered the means of making the same blue, without passing through the stage of aniline red, which they made some years before with that matter. They caused a reaction on a mixture of aniline and toluidine, the hydrochlorates of these bases; and in this manner they substituted *phenyle* and *toluyle* for the hydrogen of the aniline and the toluidine, instead of making the substitution on rosaniline; then they oxidized the new base and obtained blue.

This blue has precisely the same properties as that made with aniline red, and it ought to have the same composition. It has not, however, been extensively used. To make this blue it is necessary to employ the two bases which are required for the formation of rosaniline—aniline and toluidine—whilst the methylaniline employed in the manufacture of violet ought to be made with aniline of the purest possible quality, which would consequently yield little or no rosaniline.

There is another colour, derived directly from aniline, which we have not yet noticed. It is colourless when applied to the stuff, but develops into black when exposed to air and to certain agents.

Aniline black has until now been employed exclusively in printing on cotton. Different from all other colours derived from aniline, which are generally deficient in permanency, aniline black completely resists the action of light. There had not been any process for its application to dyeing until M. Lauth supplied the want, which he had previously done in rendering practicable Lightfoot's process of printing. Before Lauth improved Lightfoot's process, the agents employed by Lightfoot destroyed the vegetable fibre.

Thus, then, with aniline, there are obtained, either directly or in passing through the red stage, first, red colour, then blue, violet, green, and black. Other colours of less importance are also obtained; these are, greys, browns, oranges, produced at the same time with red, which is dimmed by them, and from which they are separated. Also dark blues, which are manufactured by Coupier, and which may, in certain cases, be substituted for indigo.

There are other substances derived by distillation from coal—carbolic acid, naphthaline, and anthracene. Carbolic acid, which is a powerful disinfectant, is a source of several colouring matters. One of them, picric acid, has been known for a long time. Before the advent of aniline, picric acid was manufactured by MM. Guinon, Marnas, Bonnet, and others; those makers were the first to make and apply it to the dyeing of silks. It yields a very bright clear yellow.

Since 1860 MM. Guinon, Marnas, and Bonnet, employed the process of M. J. Persoz, and obtained with carbolic acid an orange product—*rosalic* acid. This body was submitted to the action of ammonia under pressure, and yielded a very bright red; but it had no stability. Lastly, they added aniline to this red, and obtained a blue, called azuline, which is less pure than aniline blue.

With carbolic acid, likewise, maroon and brown are produced, which are not much used in France.

Numerous attempts have been made to obtain colours from naphthaline and its derivatives, but with little success. The colours so produced are wanting in beauty and stability; and it was only a short time since that M. Martius succeeded in making naphthylamine with one of the derivatives of naphthaline—a golden yellow, which is used to a certain extent.

M. Clavel, of Basle, patented a method of manufacturing with some of the derivatives of naphthaline a product which gives tints resembling aniline red. It has made very pretty roses on silk, but it is not good in the darker shades. It has been but little used.

In the long series of colours derived from coal, the last arrived at will certainly become the most important, both with respect to the general use to be made of it and the change which it will be the means of introducing in the cultivation of certain countries—artificial *alizarine*, which exists ready made in madder root. Chemists have long sought to prepare it with naphthaline, because of the analogous compositions of the two bodies. But Messrs. Graebe and Liebermann, chemists in Berlin, found that by submitting alizarine to the process of reduction described by M. Berthelot, the resulting hydrocarbon was anthracene, and not naphthaline. It was necessary, therefore, to discover the means for converting that anthracene into alizarine. Graebe and Liebermann made the discovery, and their process has been perfected more lately by Messrs. Broenner and Gutzkow. The anthracene is extracted in rectifying the solid product of the distillation of coal tar; but it is yet uncertain whether that product can be obtained in sufficient abundance to supply as much alizarine as is now obtained from madder. The annual return of the production of madder amounts in money value to two millions sterling, of which France takes up a fourth.

Artificial alizarine possesses all the properties of the alizarine produced from madder, and it has the advantage of permanence over all the aniline colours, though not so bright.

Although the manufacture of colouring matters from coal is yet in its infancy, being scarcely (1871) ten years old, it has already taken its place in the front rank of colour manufactures by the magnitude and importance of the transactions to which it has given rise. Above all others, it demands on the part of the manufacturer that he should keep a good look-out for the improvement of his operations as well as the discovery of new processes. This industry progresses and changes with surprising rapidity, as may be judged from what has been accomplished during its short existence. A product which appeared to defy competition one day might be upset the next. For example, Perkin's violet was only introduced in manufacture in 1859, and in 1861 it was rivalled and supplanted by the Imperial violet of MM. Girard and de Laire. Three years later, Hofmann's violet superseded the Imperial violet; and in two years more the Paris violet was introduced and rivalled Hofmann's violet.

The same transitional movement has taken place with other colours—for the greens, and the blues. The iodine green replaced the aldehyde green. The soluble blues partially replaced the alcohol blues, and the manufacture of them increases.

These colours, in fine, are easily applied. They have so strong an affinity for textile fibre, that they take to it generally without the interposition of a mordant. The prices also are very much reduced. Fuchsine, which was formerly sold at £13 per pound, is now sold at 11*s.* The violet of the bichromate, which was sold at 55*s.*, is now sold at 7*s.* 4*d.* per pound. Aniline itself, formerly sold at 11*s.*, is now sold for 1*s.* 1*d.* a pound.

These products are not limited in their application to dyeing only, but they are applied in many other ways, in manufacturing coloured paper, ink, lake, &c.

They are exported to the most distant countries, even to those whence came the finest vegetable colours, extracted from the plants of China, Japan, and India.

The following statement gives approximately the proportional quantities of the under-named products derived from 100 parts of coal:—

Tar	10 per cent.
Benzine . . .	1 „
Nitro-benzine . .	1·4 „
Aniline . . .	0·85 „
Aniline red . .	0·25 „

Preparation of the Raw Materials derived from Coal employed in the Manufacture of Colours.

The first step is to distil the coal in clay retorts raised to a red heat. Gas is disengaged and escapes by a pipe leading from the upper part of the retort, the oleaginous substance is at the

same time vaporized and discharged; it is condensed by cooling, and is collected in large tubs. The gas is purified and collected in gas-holders for lighting purposes. The oleaginous substance is tar, which is yielded in considerable quantity. It was an incumbrance to gas-works before the method of utilizing it was discovered. It contains a considerable number of chemical products, which are separated by special distillation with appropriate treatment. Of these products the following are those which are utilized for the production of colours :—

Benzine	C^6 H^6
Toluene	C^7 H^8
Xylene	C^8 H^{10}
Naphthaline	C^{10} H^8
Anthracene	C^{14} H^{10}
Carbolic acid	C^6 H^6O
Aniline	C^6 H^7N

When coal-tar is distilled to a state of dryness, the fixed residue is pitch, which is mixed with shale, and moulded into briquettes for fuel.

Benzine, C^6 H^6—Toluene, C^7 H^8—Xylene, C^8 H^{10}.

The article known in commerce by the name of benzine is almost always a mixture of benzine and homologous products—toluene, xylene, &c.; and it is such a mixture, in variable proportions, or at least a mixture of benzine and toluene, which is generally employed in the manufacture of colours.

Benzine, when pure, is a volatile and colourless oil, with a boiling point of 176°, and a specific gravity of 0·85. It is very inflammable, and the flame is not extinguishable by water, as the oil floats on the surface. It becomes a solid at about 32° Fah. It was discovered by Faraday in 1825, and in the same year Hoffman announced the fact of its existence in coal-tar.

In the process of separating benzine from the numerous other products with which it is mixed in coal-tar, the lighter products, or those which are lighter than water, are in the first place separated by distillation from the heavier products; and they are redistilled several times after having been treated with sulphuric acid, when a mixture, limpid and colourless, is obtained, consisting of benzine, toluene, xylene, &c. By further repeated distillations, or by one distillation in an apparatus suitably arranged, these various bodies finally are separated. Benzine passes off at the lowest temperature, 176° Fah.; then toluene, at 230° Fah.; and xylene, at 266° Fah. It was Mansfield who, in 1847, proved the existence of toluene in coal-tar. The same substance is produced by the dry distillation of Tolu balm yielding a mixture of benzoic ether and toluene, having a specific gravity of 0·84, which though resembling benzine, differs from it in many of its properties.

Xylene, a homologue of benzine, like toluene and cumene, was discovered by Cahours, in 1850, in the oil which is separated from raw wood-spirit by the addition of water. It is of little importance for the manufacture of colours.

Nitro-Benzine, C^6 H^5 NO^2—Nitro-Toluene, C^7 H^7 NO^2.

The article of commerce known as nitro-benzine is almost always a mixture, in varying proportions, of nitro-benzine and nitro-toluene. Nitro-benzine was discovered in 1839, by Mitscherlich. It is an oily fluid, slightly odorous, recalling the odour of the essence of bitter almonds. It is solidified at a temperature below the freezing point,—say 26·5° Fah.; it boils at 415° Fah. Its specific gravity is 1·209, and it is inflammable.

Nitro-toluene has many of the physical properties of nitro-benzine; its boiling point is 437° Fah., and its specific gravity is 1·180.

Nitro-benzine and nitro-toluene are obtained by adding fuming nitric acid to the respective hydrocarbons. The process is not without danger. When first introduced it was the cause of several explosions. The manufacture is now reduced to a system, and several manufacturers turn out thousands of pounds weight daily. The process is conducted in iron vessels, cylindrical, and capable of holding from 220 to 330 gallons. The whole quantity of benzine to be converted is put in at once, and is stirred about by an agitator, whilst a mixture of sulphuric and nitric acids is introduced through a tube; the whole mass is thus continuously mixed, and the reaction is moderated or stimulated at will by surrounding the vessel by cold water or by steam, introduced into a jacket. When the conversion is completed the products are run off, and they separate into two strata, one of which is the oily nitro-benzine and the other the reduced acid mixture.

The nitro-benzine should be well washed with water, and afterwards with a little soda, to neutralize the free acid remaining in it.

Aniline, C^6 H^7 N,—Toluidine, C^7 H^9 N.

These are the last intermediary products before producing the greater part of the colours. The article sold as aniline is usually a mixture of aniline and toluidine. Aniline was discovered in 1826, by Unverdorben, whilst distilling indigo. In 1834 Runge discovered the existence of aniline ready formed, when distilling coal-tar; and, more recently, Hoffman pointed out a means of separating it, but unfortunately it is found in but small quantities. Zinin was the first who discovered that nitro-benzine could be converted into aniline; and afterwards Béchamp improved Zinin's process, and gave to manufacturers a practical process, just at the moment of the discovery of aniline colours, in 1859, and which contributed not a little to the rapid development of the manufacture of these colours.

Aniline is an oily product, slightly coloured, which boils at 360° Fah. It has a powerful aromatic odour, and is a strong poison. It combines with acids, and forms salts, which are generally soluble in water.

Toluidine is obtained, like aniline, by the reduction of nitro-toluene. It boils at 388° Fah., and has a density of 1·012. It is solid at ordinary temperatures, but it is almost always mixed with pseudo-toluidine, and in this state it only crystallizes at temperatures below zero, separating itself from the pseudo-toluidine.

Pseudo-toluidine was recently discovered by Rosenstiehl. It is always formed at the same time with toluidine. Its boiling point is the same, and has many properties in common with toluidine; but Rosenstiehl knew how to find the reaction which served to distinguish the two products, and to separate them. He has also pointed out the part taken by each of these alkaloids in the manufacture of red.

Aniline is prepared in large cast-iron cylinders, of the form and capacity of those employed in the manufacture of nitro-benzine, with an agitator also. The cylinder is first charged with very dilute nitric acid, which is stirred about; a quantity of powdered cast-iron is then added, and finally the whole of the nitro-benzine to be converted. A lively chemical reaction takes place; the vapours are condensed in a cohobator, situated above the cylinder, and fall back again. Little by little, fresh quantities of powdered iron are added.

When the nitro-benzine is converted into aniline, which is determined by the complete solution of a portion of the liquid in muriatic acid, steam is injected into the mass of liquid, and thus the aniline is separated. It is subjected to a second distillation, and is then employed for the manufacture of colours.

Methylaniline, C^6 H^6 (C^2 H^3) N—Ethylaniline, C^6 H^6 (C^2 H^5) N.

These bases are compound anilines; that is to say, anilines in which a molecule of ethyl or of methyl is substituted for a molecule of the hydrogen of the aniline. They are oily liquids, of a light yellow colour, and their boiling points are higher than that of aniline. These bases are obtained, as already mentioned, in the works of M. Poirrier, by an entirely new process. A salt of aniline, the hydrochlorate, and the alcohol of which the base is to be obtained, are put into a vessel capable of sustaining a high pressure. The vessel is hermetically sealed, and heat is applied for some hours at varying temperatures, according to the nature of the alcohol and its boiling point—say from 440° to 480°, or even to 580° Fah. When the operation is ended the contents are allowed to cool and the liquid withdrawn. The product is the hydrochlorate of the new base, which is decomposed by the addition of a certain quantity of lime; the mixture is distilled, the portions which pass over at from 370° to 410° Fah. being kept separate, if they be methylaniline; and these are the portions which are used for conversion into colour.

By the addition of anhydrous bichloride of tin, methylaniline changes immediately to a fine violet blue.

Diphenylamine, C^{12} H^{11} N.

Diphenylamine is obtained, by the process of Girard and de Laire, by heating under pressure two parts of the aniline of commerce and one part of the hydrochlorate of aniline at a temperature of about 480° Fah.

Carbolic Acid, C^6 H^6 O—Naphthaline, C^{10} H^8—Anthracene, C^{14} H^{10}.

Mr. Calvert was one of the first to obtain carbolic acid on a commercial scale in a state of remarkable purity. The carbolic acid is solid, crystallized, and colourless; it has a strong odour of smoke; it is burning to the taste. Its specific gravity is 1·065, and it boils at 370° Fah. It is employed in medicine.

Phenic or carbolic acid is obtained by collecting the vapours

which pass over between 320° and 374° Fah. in the distillation of coal-tar. They are treated with a feeble lye of soda, with which carbolate of soda is formed ; this salt is decomposed by sulphuric acid, and the oily product is distilled ; and, after having separated the lighter from the heavier products, the pure acid is obtained in the form of crystals.

Naphthaline is solid, colourless, and exists as a crystal, with a strong odour of tar. It boils at about 430° Fah. It is found in great quantity in the heavy oils distilled from tar, after the carbolic acid has been separated. Naphthaline is placed in a solid mass in the press. The product is submitted to sublimation, and yields nearly pure naphthaline, since it has a low boiling point, and vaporizes easily. Treated with nitric acid, naphthaline is converted into nitro-naphthaline which, reduced like nitro-benzine, is converted into naphthylamine ($C^{10} H^9 N$), a base analogous to aniline.

Anthracene is obtained, according to MM. Broenner and Gutzkow, by exposing pitch or asphalte in a retort to the action of superheated steam. In distilling the heavy oil of tar a glutinous product is discharged at the end of the process, of an orange colour, which contains a considerable quantity of anthracene.

Having now passed in review the operations for obtaining tar from coal, and the numerous products from tar, with the conversion of certain of these products—as benzine into nitro-benzine, nitro-benzine into aniline, and aniline into methylaniline, diphenylamine, &c.—we proceed to a consideration of the method of obtaining the colours.

Preparation of Various Colours derived from Aniline.

Aniline Violet, Mauveine ($C^{27} H^{24} N^4$), Rosalane, Indisine, &c.

Perkin's violet, which was named mauveine by the inventor, is, as a base, known also as rosalane, indisine, &c.—names which have been given by various manufacturers. Mauveine is the first colour obtained on a commercial scale derived from aniline. It is a violet red, less bright than the other violets which have since been obtained, but possessing a greater degree of permanency when exposed to air. The salt may be obtained as crystals of a fine bright green, but it is usually delivered in the condition of paste.

This violet is obtained by mixing solutions, cold or nearly cold, of sulphate or of hydrochlorate of aniline and bichromate of potass, equivalent for equivalent. As the mixing proceeds a black precipitate is formed and the temperature is raised. The mixture is left for some time, say twenty-four hours, at rest ; the black precipitate is then washed several times with cold water, to remove the salts, which tend to prevent dissolving. After having been sufficiently washed it is treated with thirty or forty times its weight of boiling water, and kept boiling for an hour. The black mass left at rest is deposited, and the liquor turns out of a strong violet colour. The liquor is filtered and a certain quantity of sea-salt is added to it, after which the violet is precipitated in flakes. The liquor is again filtered and the colouring matter is collected on the filter.

Perkin, in the specification of his patent, recommended the addition of benzine to purify the black mass, and afterwards hot alcohol. This treatment is still followed, to some extent, by some manufacturers ; but it requires the use of costly apparatus, and gives products of less purity than the process above described ; they require, therefore, to be again dissolved in water to arrive at the desirable degree of purity.

The success of this manufacture depends very much upon the nature of the aniline and the temperature at which it is treated ; and it demands the greatest degree of care.

Aniline Red.—Rosaniline, $C^{20} H^{19} N^3$, H^2O.

Fuchsine.—Roseine.—Magenta.

Aniline red, like Perkin's violet, is sold under different names. The name fuchsine was conferred upon it by MM. Renard ; it derived from the German word *fuchs*, meaning *renard*, a fox.

Aniline red is the salt of a colourless base, rosaniline, so called by Hofmann. It is generally delivered in the form of crystals of a fine bright green, which yield a magnificent red solution in alcohol or hot water. Its colouring power, like that of all the other aniline colours, is immense. One kilogramme (2·20 pounds) of aniline red is sufficient for dyeing from 12 to 15 pieces of merino, according to the shade, measuring together from 1,000 to 1,200 meters (1,084 to 1,300 yards) in length.

Verguin obtained aniline red by the reaction of anhydrous bichloride of tin on aniline. The red was fine, but there was little of it. Other re-agents were employed which gave larger yields. Arsenic acid became very soon the only re-agent employed, and it is still almost exclusively employed. It leaves much to be desired, however, in respect of the quantity of the yield, for there are much more of violets, yellows, and browns, than of reds. It is, moreover, a poisonous agent, which demands the greatest precaution in using it, in order to avoid accidents. Various attempts have been made to replace arsenic acid, and with a certain degree of success.

The manufacture of aniline red was at first limited to the production of from 10 to 20 pounds at a time. It is now conducted on a considerable scale. Into a retort of suitable capacity there are put together

500 kilogrammes (1,100 pounds) aniline.
750 „ (1,650 „) arsenic acid, at 75 per cent.

The mixture is heated and constantly stirred by means of revolving paddles on a central axis. Water and aniline are distilled and condensed in a worm connected to the retort. This operation lasts for some hours, and it is ascertained to be sufficiently advanced by sampling the mixture and cooling the sample, when, if the operation is completed, it becomes hard, and has a bright fracture. The fire is then withdrawn, a quantity of boiling water is added, and a jet of steam thrown into the retort. The untouched aniline is carried off, and the fluid mass is conducted into other capacious vessels, fitted with agitators, where it is kept boiling for several hours. Carbonate of lime is added, which seizes the arsenic acid, and forms an insoluble salt. The mass is left to settle ; the solid or resinous matters are deposited, and the liquid is filtered into large tubs. On cooling, the aniline red is deposited on the sides of the tubs, in the form of bright green crystals, which are collected and dried.

The quantity of red obtained varies according to the composition of the aniline employed—that is, according as it contains more or less aniline, toluidine, and pseudo-toluidine.

We have said that aniline red was the salt of a colourless base, rosaniline. For the formation of blue, violet, green, &c., rosaniline is often employed instead of the salts ; and it may be well to describe how it is prepared. To a weak solution, boiling, of very pure aniline red, a quantity of soda is added sufficient to decompose the salt. Ebullition is continued for some time, and on the liquid being left to cool a fine white crystalline powder is deposited. This is rosaniline.

Aniline Blue, Triphenylic Rosaniline ($C^{38} H^{31} N^3 H^2O$,) Imperial Violet, Soluble Aniline Blue, discovered by Girard and de Laire.

Aniline blue is a powder having the appearance of bronze, sometimes dark blue. It is soluble in alcohol and wood-spirit, and yields a brilliant blue dye. The dyeing is effected in the presence of acid or of certain mordants. Without the addition of these agents the dye will only yield a violet or a dull grey.

Imperial violet, which is a product of the same nature as aniline blue, behaves in the same manner as this dye.

Nicholson found that aniline blue combined, like indigo, with sulphuric acid, and thus became soluble in water. This soluble blue is employed with success, particularly in one way, which gives very good results (dyeing in a neutral bath, and reviving in an acid bath). It is daily extending in use. This blue is obtained in an enamelled cast-iron retort, fitted with an agitator, from the following mixture :—

11 pounds salt of rosaniline, say the acetate.
33 „ light aniline.

It is heated to 356° Fah., and passes first to violet, then to blue. The operation is completed when a sample taken from the mass yields a pure blue when dissolved in alcohol. The product is then poured into a vessel containing very dilute muriatic acid, which takes up the aniline in excess. The blue is precipitated, and is separated by filtration, washed in boiling water, pulverized, and dried.

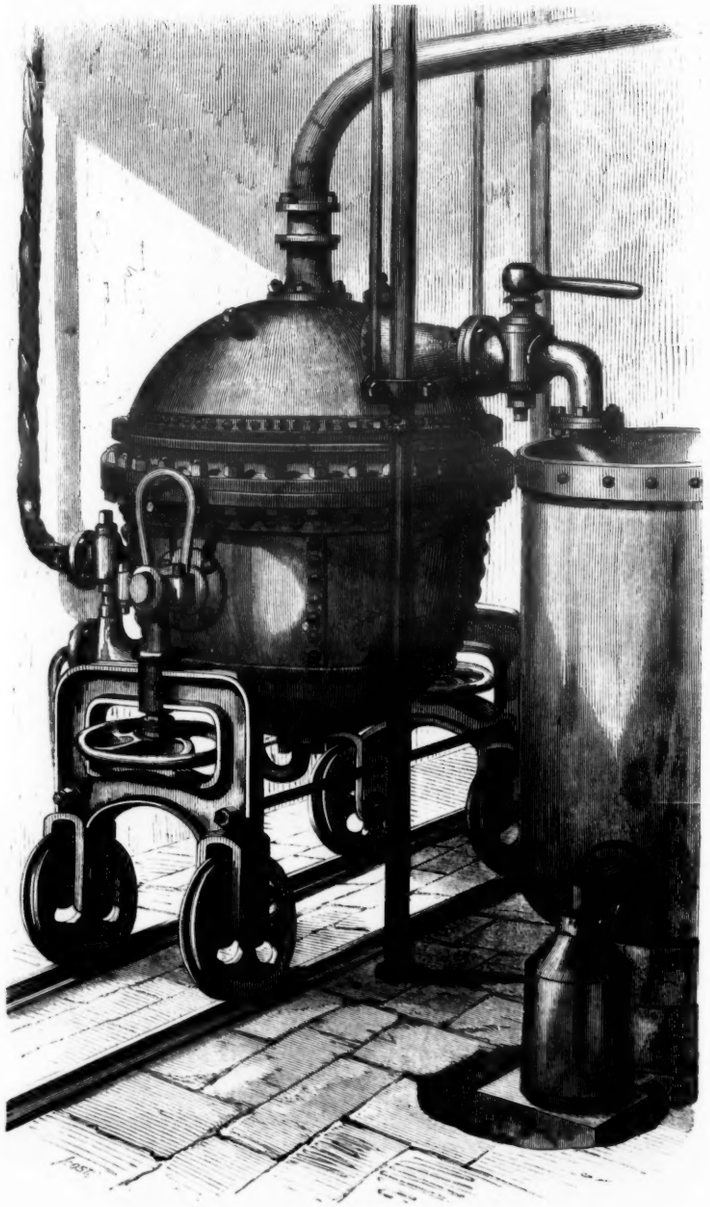
To obtain very pure blues, alcohol is added to a fine ordinary blue. The reddish blue being more soluble is dissolved, leaving the green blue, which is separated by filtration.

Imperial violet is obtained precisely as blue is obtained, except that the operation is arrested at an earlier stage, and it is treated in the same way.

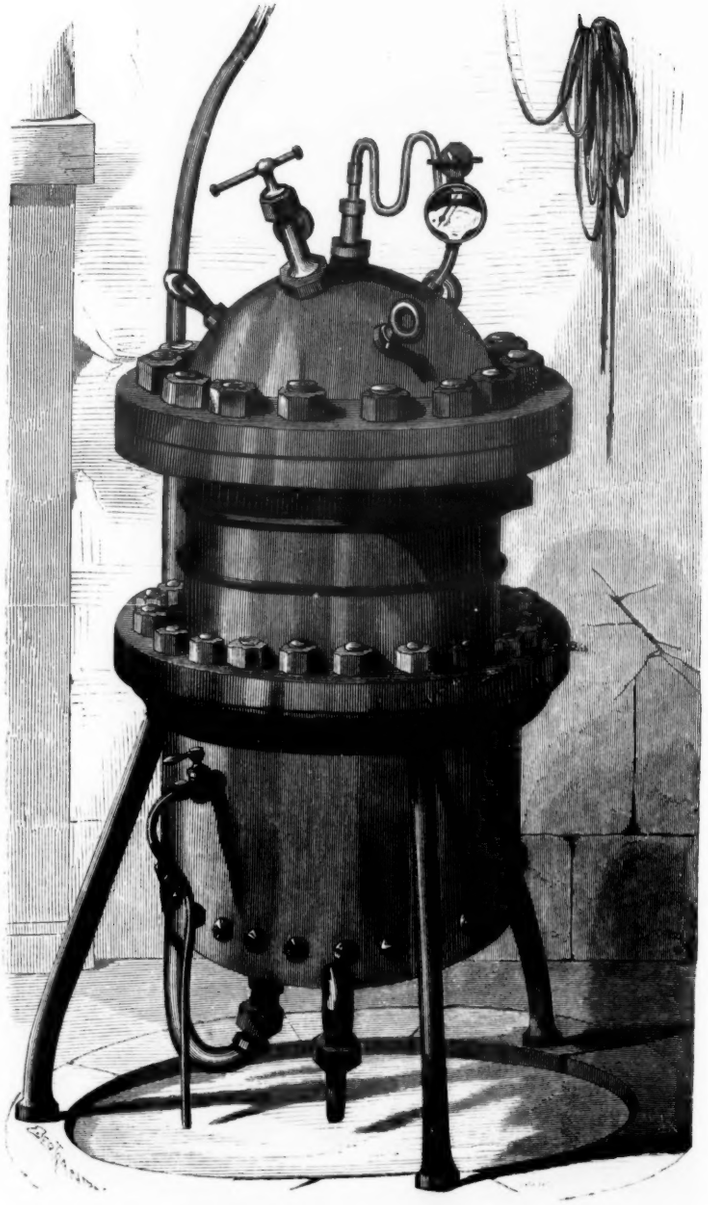
To render blue soluble there are mixed :

1 part of blue,
4 to 6 parts of concentrated sulphuric acid.

The mixture is heated to 300° Fah., and the operation is stopped when a sample is dissolved either in pure water or in water slightly alkaline. The excess of acid is then removed by washing in small quantities of water, and by the addition finally of an alkali to neutralize it.



MANUFACTURE OF HOFMANN VIOLET.



CLOSED VESSEL FOR HEATING UNDER PRESSURE.

Hofmann Violets.

Rosaniline, mono-ethylated, C^{20} H^{23} N^3 H^3 O, red shade.
Do. di-ethylated, C^{24} H^{27} N^3 H^2 O, medium shade.
Do. tri-ethylated, C^{26} H^{31} N^3 H^2 O, blue shade.

Iodine Green, (C^{25} H^{31} N^3 I^2, H^2 O.)

The Hofmann violet differs from the Imperial violet in this, that the latter is a carbolized rosaniline, whilst the former is a methylated or ethylated rosaniline. In substituting ethyle or methyle, blue is never obtained, but a strong blue violet and a green.

The Hoffman violet in a pure state is a bright green mass, which becomes when dissolved in water a magnificent violet. But the hydriodate is only soluble in alcohol. It is prepared in close vessels.

When the operation is conducted in a close vessel, an enamelled boiler is chosen having a double bottom, which is heated by steam, or in an oil bath. The following ingredients are mixed in it :—

11 pounds rosaniline.
55 do. alcohol or wood-spirit.
26 to 33 do. iodide of ethyle or of methyle.

The mixture is heated for three hours at a temperature of about 212° Fah.

When iodide of methyle is used, green is produced as well as violet. The colours are separated by boiling the mass in a certain quantity of water, after having been freed from the excess of the iodide. When cold the liquid is filtered, the green remaining in solution, and the violet as a hydriodate is precipitated, and the small quantity of violet which may remain in solution is separated by the addition of a small quantity of alkali. The liquid is again filtered, and the green is precipitated in flakes by the addition of a solution of picric acid. It is collected on a filter.

The Hofmann violet, parted from the green, is treated with a boiling solution of soda. The soda seizes the iodine, forming iodide of sodium, and the violet remains as a colourless base. The iodide is afterwards decomposed to recover the iodine.

The violet base is treated with muriatic acid, in quantity sufficient to form with it a neutral salt, and the product is entirely soluble in water.

If instead of iodide of methyle, the iodide of ethyle is used, there is only formed a small quantity of green, and the mass is treated in the same way as above described for the Hofmann violet, previously separated from the green.

Aldehyde Green.

This green, like the iodide green, the Hofmann violet, the blue, and the Imperial violet, is derived from aniline red.

The red is, in the first place, turned into a particular blue, which has already been noticed, by the action of aldehyde. The following is the ordinary process :—

1 part of aniline red is dissolved in a mixture of
2 do. sulphuric acid.
2 do. water.

The mixture is heated ; and when cooled, two parts of aldehyde are added by degrees, and the whole is left together. It is sampled from time to time ; and when a pure blue is obtained by dissolving the sample in water, the whole is poured into about 90 gallons of boiling water, containing in solution about 2·20 pounds of hyposulphite of soda. The new mixture is stirred, and then filtered. The liquor contains the green, and is used in dyeing ; or the colouring matter is precipitated as a paste, either by tannin or by acetate of soda. It is usually sold in the state of paste.

Colours derived from Compound Anilines.

Paris Violet.

Paris violet, like Hoffman violet, exists as a bright green mass, which when dissolved in hot water, or even in cold water, becomes a very lively violet. It is of various shades, from very red violet to very blue violet. It fixes itself upon wool or silk, like aniline red and the Hoffman violet, without the addition of either mordant or acid.

It is obtained by oxidizing a compound aniline containing the base of an alcohol or the bases of different alcohols. Methylaniline and dimethylaniline are generally used. Methylaniline is easily made to produce violet. The following process, patented by MM. Poirrier and Chappat, gives a very good result :—Into an enamelled cast-iron heater, having a capacity of 55 gallons, and placed in a hot-water bath, are put

100 pounds of methylaniline.
88 do. chlorate of potass.
22 do. iodine.

The chlorate of potass and the iodine are added by degrees during some hours. When the first doses are added, the mixture is heated up to from 175° to 212° Fah. ; at this temperature it is maintained for four or five days, when a hard mass of a fine bronze green is obtained. This mass is treated with a solution of soda. The chlorate in excess is dissolved, and the iodine unites with the soda. The violet, as a base, is precipitated as a dark brown mass, and is treated with boiling water to remove all traces of the iodide of sodium. It is again treated with boiling water containing muriatic acid in sufficient quantity to form a neutral salt with the base. Violet is produced, and the liquor is filtered to separate impurities. Sea-salt is added, and the colouring matter is precipitated as a viscous product of a fine bright green colour, which is dried and pulverized for the market.

Diphenylamine Blue.

This blue, patented by Girard and de Laire, is obtained by the reaction of sesquichloride of carbon with a mixture of diphenylamine and ditoluylamine, say—

1 part of the alkaloids,
1½ do. of the sesquichloride,

heated to from 320° to 356° Fah. The mass is converted into a bronze-coloured product, which is purified by washings in benzine and alcohol. This blue is similar to rosaniline blue.

Aniline Black.

Aniline black is produced directly upon the stuffs by printing or by dyeing. Unlike other aniline colours, it develops very well upon cotton ; it has not yet been well developed on wool. For printing on cotton the following is the process followed by Lauth, and generally by others, Lightfoot's process having been generally abandoned by reason of the injury it does to the fibres :—

10 litres (22 gallons) starch.
350 grammes (0·77 pound) chlorate of potass.
300 „ (0·66 „) sulphide of copper in paste.
300 „ (0·66 „) sal-ammoniac.
800 „ (1·76 „) hydrochlorate of aniline.

The web is printed with this mixture, and hung up in an airy chamber. The black is developed, and is then washed in pure or alkaline water.

Aniline black is obtained by dyeing according to the following process patented by Lauth. The cotton is treated with a mordant of a concentrated solution of a salt of manganese, and dried, then passed into an alkaline bath, and exposed to the air ; again washed and passed through the dyeing bath, containing the following mixture :—

100 litres (220 gallons) of water.
5 kilogrammes (11 pounds) of aniline.
10 „ (22 „) of hydrochloric acid.

When removed from the bath the piece has a deep green colour ; it is washed in water or in an alkaline bath, and a magnificent black is produced. If the piece be passed through an additional bath of bichromate of potass, the black becomes still more intense.

Colours derived from Carbolic Acid, Naphthaline, and Anthracene.

Picric Acid.

Picric acid, when pure, is sold in the form of spangled crystals of a clear yellow colour. It is soluble in water and in alcohol. It is obtained by gradually adding nitric acid to carbolic acid, or to a mixture of carbonic and sulphuric acids.

It dyes in yellow, and, above all, in light green, by mixing it with blue. Treated with cyanide of potassium, it is converted into isopurpuric acid, which gives a red colour. The ammoniacal salt of this acid yields a colouring matter analogous to murexide. The isopurpurates, when dry, detonate by the slightest shock.

Rosalic Acid.—Coralline.—Azuline.

Rosalic acid is obtained by heating this mixture :—

1 part of oxalic acid.
1½ „ carbolic acid.
2 „ sulphuric acid.

Rosalic acid yields an orange-yellow colour. Submitted to the action of ammonia under pressure, at a temperature of 300° Fahrenheit, this product is converted into a red colouring matter,

to which MM. Guinon, Marnas, and Bonnet gave the name coralline. It does not resist the action of light.

The same manufacturers have obtained the blue colouring matter which they have called azuline, by heating the red product with aniline.

Colours derived from Naphthaline.

Many attempts have been made to obtain colours with naphthaline, but the only colours hitherto produced have been yellow and red.

The yellow is produced according to Martin's process by the action of nitrate of soda upon the hydrochlorate of naphthaline. A liquor is obtained, which, when boiled with nitric acid, gives small yellow needles, which rise to the surface, and are collected. This body is analogous to picric acid, but it gives yellow shades more of a golden tint.

Naphthaline Scarlet.

This body was discovered by Schiendel, and patented by Clavel, of Basle. It is produced from two alkaloids—naphthylamine and an oily product, which is formed at the same time, and is distilled at a higher temperature. The last product is treated with the nitrate of the protoxide of mercury, and is heated at a low temperature. A brown colouring matter is formed, which is separated from the mercury and from the tarry products formed at the same time. This brown matter is mixed with a certain quantity of naphthylamine; the whole is heated, and red is formed, which is separated from impurities in the same manner as is practised for aniline colours.

An analogous product is formed, according to M. Ulrich, who patented it in 1868, by adding nitrate of lead to acetate of rosaniline, and then applying to the product thus obtained an alcoholic iodide.

Artificial Alizarine.

Graebe and Liebermann, who discovered artificial alizarine by means of anthracene, have patented a process which has since been perfected by Brœnner and Gutzkow. These chemists treat anthracene with an oxidizing agent, such as the bichromate of potass, with sulphuric or other acid, and by preference they use nitric acid as the oxidizing agent, in quantity twice the weight of the product. The resulting body is purified by evaporation or crystallization, and then dissolved in sulphuric acid with heat. Nitrate of mercury is added, the colouring matter is formed, and is extracted by means of an alkaline bath which develops the colours. It is filtered and precipitated by the addition of a small quantity of acid in the bath, and then purified by crystallization or evaporation.

The same shades are obtained with this product as with the natural alizarines and purpurine, and they are as durable.

The Chinese White Wax Insect.—(*Pharm. Journ.*, 3rd series, ii., 569.) In his interesting volume, "Travels of a Pioneer of Commerce in Pig-Tail and Petticoats, on an Overland Journey from China towards India" (Murray, 1871), Mr. T. T. Cooper gives the following account of this insect, a species of coccus:—Chemists have long known the so-called "vegetable wax," "Chinese wax," or "pela," also called "vegetable insect wax," or "vegetable spermaceti," but we have had no definite knowledge before of its history or mode of production. It was generally stated to be produced on certain trees by the puncture of a species of coccus. But Mr. Cooper supplies us with the first definite statement we have seen of what proves to be an extensive industry. Unfortunately, he does not appear to have secured specimens of the insects producing it, nor does he give us more definite information of the plant of which they feed than that it resembles our privet. Mr. Cooper describes the cultivation of wax as a source of great wealth to the province of S'zchuan, where it ranks in importance second only to that of silk. The eggs of the insect which produces the wax are imported annually from the districts of Hochin or Hoking and Why-li-tzou in Yunnan, where the culture of the eggs forms a special occupation by merchants who deal in nothing else but pa-la-tan, "white wax eggs." The "wax-trees" are all uniformly cut down to a height of about eight feet, without a single branch, the stumps being as thick as a man's thigh. The clusters of eggs, about the size of a pea, enclosed in balls of the young leaves, are suspended to the shoots by strings, about the middle of March. By the end of the month the larvæ make their appearance, feed on the branches and leaves, and soon attain the size of a small caterpillar, or rather a wingless house-fly, covered with white down, with a delicate plume-like appendage, curving from the tail over the back. They are so numerous, that the branches of the trees are whitened by them, and appear as if covered with feathery snow. The grub proceeds in July to take a chrysalis form, burying itself in a white wax secretion, just as a silkworm wraps itself in its cocoon of silk. All the branches of the trees are thus completely coated with wax an inch thick, and in the beginning of August are lopped off close to the trunk and cut into small lengths, which are tied up in bundles and taken to the boiling-houses, where they are placed, without further preparation, in large caldrons of water, and boiled until every particle of the waxy substance rises to the surface; the wax is skimmed off and run into moulds, in which shape it is exported to all parts of the empire. It would seem that the wax-growers find that it does not pay them to reserve any of the insects for their reproductive state, and hence the necessity of importing the eggs from Yunnan.

To this account Professor Silliman adds the following notes in the "American Naturalist" for November, 1871:—This insect wax is a definite compound somewhat resembling spermaceti in appearance, but not in composition, being a cerotic ether, known as cerotate of ceryl, of the formula $C_{59}\,H_{118}\,O_2$. It is crystalline, and of a dazzling whiteness, like spermaceti, but more brittle and of a more fibrous texture. It does not completely saponify by boiling in potash water, but is completely decomposed when melted with potash, yielding cerotate of potassium and hydrate of ceryl. It is consumed in China for candles and also as a medicine. It melts at about 118° F. It does not appear clearly from Mr. Cooper's statements whether this wax is secreted by the insect, or is not rather an exudation from the stems of the trees punctured by the insect. Mr. Cooper plainly favours the former supposition; but other writers of more pretensions to science entertain an opposite view. The plant on which the Chinese coccus lives is stated to be *Ligustrum lucidum*. There are several sorts of vegetable wax, well known to chemists and new to commerce, and we find it stated by the Rev. Justin Doolittle, in his "Social Life of the Chinese," that the "vegetable tallow" of China is obtained from the seeds or kernels of the so-called "tallow-tree." But he also states that the tallow is hardened by a very hard white wax brought from the western or north-western provinces of China, which is the very wax described by Mr. Cooper. The "tallow" is not a wax in chemical constitution, and is the product of a shrub know as *Stillingia sebifera*. The American myrtle-wax (bayberry tallow) is a solid fat, melting at about 118° F., and contains a large quantity of palmitic and a small quantity of myristic acid. From its high melting-point and general physical and chemical properties, we might infer that the white wax of China was the product of the coccus rather than of the plant on which it feeds, seeing the properties alluded to are more like those of beeswax than of vegetable wax, known as such.

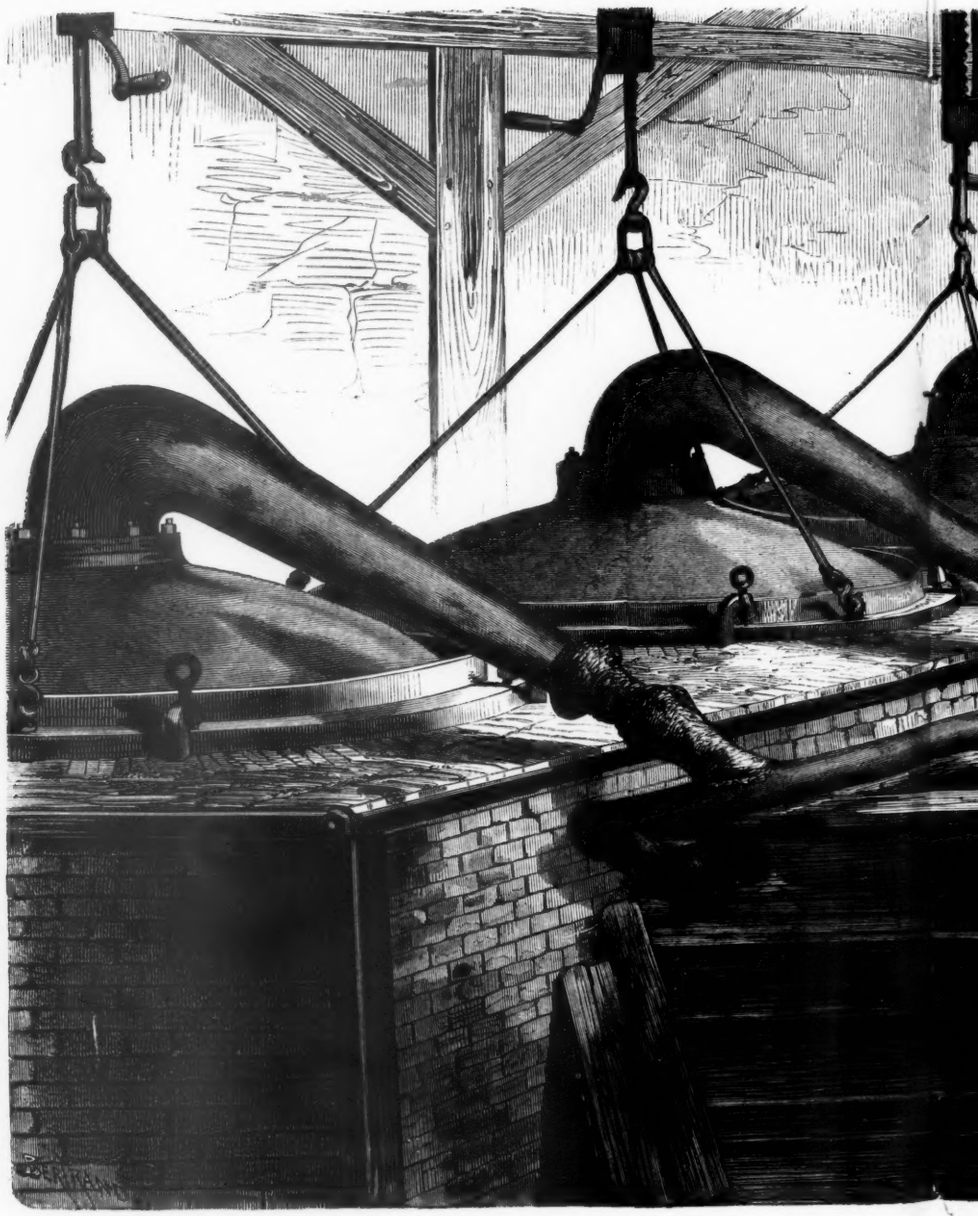
Professor Westwood, in his "Modern Classification of Insects," vol. ii., p. 449, says that "The *Coccus ceriferus*, Fabr., described by Anderson in his letters from Madras, and by Pearson in the *Phil. Trans.*, 1794, is employed in the production of a white wax, the body of the females being enveloped in a thick and solid coat of wax;" and the editor of the "American Naturalist," the well-known entomologist, Mr. A. S. Packard, jun., adds, "It is now known that this wax, as well as that of the honeybee, is secreted by numerous minute excretory sacs or follicles lodged just beneath the skin of the abdomen."

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(44.)

The Geometrical Solids and their application to Working Drawings in the Constructive Arts.—The same method of finding a series of points by means of ordinates, illustrated in previous notes under the present head, as in fig. 127, note No. 33, p. 313, vol. i., is used in the problems connected with the construction of groined arches and the development of the surfaces of their soffits. A "groin" is a line or curve generated by the intersection of arched vaults crossing each other at determinate angles, as illustrated in fig. 171.

To find the curves of the arches of the groined arch in fig. 171.—The points of the piers for supporting the arches are given at *a b c d; a e b* is the given arch at the end, which, in this example, is semi-circular; and the lines *b i a d* give the lines or seats of



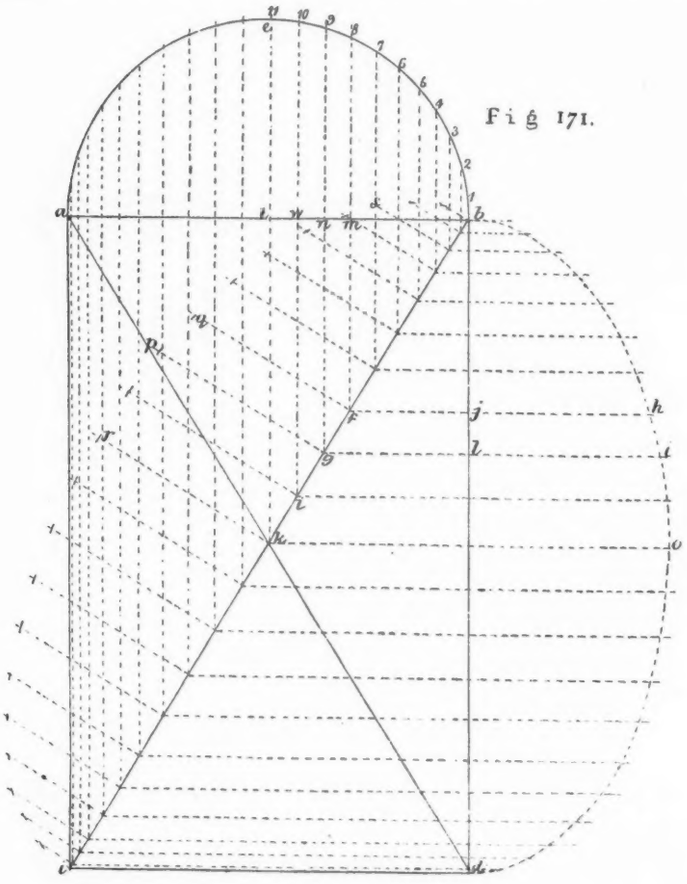
THE DISTILLATION OF M

OF METHYLANILINE.

[*See Page* 39.

the groin intersecting at *k*. *To find the curve of the arches* between the points *b i a c* at the sides. Divide the quadrant *b e* of the semi-circle *a e b* in any number of equal parts, and from the points draw ordinates, as 8 *f*, 9 *g*, &c. &c., cutting the line *b k* in the points *f* and *g*, &c. From the points in *b k* draw parallel to *a b* the lines as *f h*, *g i*, &c. &c., cutting a line joining *b d* in the points *j l*, &c. Then take the distance *m* 8, one of the ordinates cutting *a b*, and set it off from the point *j* on *b d*

Fig 171.



to *h* on the line *f h*, and the distance *n* 9, and set it off from *l* to *i*. Do this with all distances, as the ordinates in *a b*, and a series of points will be found, *o i h b*, through which, by a

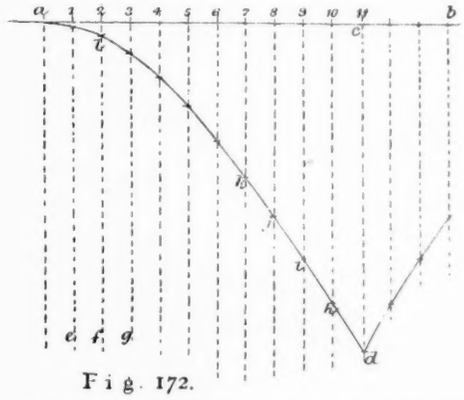
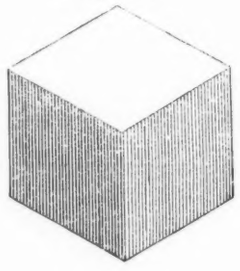


Fig. 172.

trammel or by hand, draw the curve giving one half of the elliptical arch required stretching from *b* to *d*. *To find the curve of the groin from the point b to k.* From the points on the line *b k*, as *g* and *f*, draw at right angles to *b k* the lines as *g p*, *f q*, &c. &c., and set off on these lines the lengths of the ordinates taken from *a b* to the points intersecting the quadrant *b c*; thus *f q* is equal to *m* 8, *g p* to *q n*, &c. &c. And through the points obtained, as *r p q s*, the curve of the half of the groin *b p* is obtained by drawing a line through them. The remaining halves of this end of arch *p i* are put in as shown in the drawing, and as described in connection with preceding subjects. *To find the development or "stretch-out"* of the narrower part, as *a k b*. Draw any line, as *a b*, fig. 172, and set off on this from the

Fig. 173.



point *a* eleven parts, each equal to one of the parts of the quadrant *b e*, fig. 171, reaching to the point *c*; draw *c d* at right angles to *a b*, and parallel to this, lines as 1 *e*, 2 *f*, 3 *g*, 10 *h*, through all the points between *a* and *c*. Then from fig. 171 (previous figure) take the distance *t k*, and set it off from the point *c* to *d* in fig. 172, with distance *w i*, from fig. 171; set off from 10 in *a b*, fig. 172, the distance 10 *h*; with *n g*, from fig. 171, the distance 9 *i*, fig. 172; with *n g*, from fig. 171, the distance 8 *j*; and with distance *m f*, fig. 171, the distance 7 *k*, fig. 172, and so

on. By these operations a series of points will be obtained on the lines in fig. 172, through which a curve will be drawn as shown. The other half of the curve will be put on in the same way. The part *a d c* is half of the stretch-out required. The same principle of operation is carried out in projecting the intersection of solids, in connection with which we shall give in a succeeding note a few problems, meanwhile proceeding to the development of the other solid bodies, as the cube, pyramid, &c., not yet gone into, beginning with the cube.

The Cube and the Development of its Surfaces.—A "cube," fig. 173, or "hexahedron," is, as this latter name signifies, a six-sided solid, each boundary side being a square, and all the sides equal. To find the development of the solid in a series of flat surfaces, which, when folded and placed with their edges in juxtaposition, will form the solid; draw any two lines, *e f*, *g h*, fig. 174, at right angles, intersecting at *i*. With any distance in the compasses, as *i j*, equal to half the length of side of the intended cube, set off from *i* to *j k l* and *m*. Through these points draw, parallel to *e f*, *g h*, lines forming the square *a b*, *c d*, the length of the side of which is equal to twice *i j*. Produce the lines *j* and *k* to *n o*, *q p*, and the lines *l*, *m*, to *r s* and *t w*. Make *a n* equal to *a b*, and through *n* draw, parallel to *r s*, a line *n q*, cutting *c q* in *q*. From *a* set off the distance *a b* to *r*, and draw *r t* parallel to *n o*. From *c* set off the distance *c d* to *u*, and the same distance from *u* to *s*, and from *w* and *s* draw lines to *u v*, *s w*, parallel to *p q*. Supposing the diagram to be drawn upon thick cardboard, with a sharp knife cut the cardboard through its thickness, on the lines bounded by the

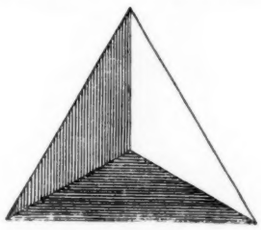


Fig. 175.

points *p o*, *o b*, *b t*, *t r*, *r a*, *a n*, *n q*, *q c*, *c s*, *s w*, *w d*, and *d p*. Next cut the cardboard *half through its thickness*, in the lines bounded by *a c*, *c d*, *u v*, *d b*, and *b a*. Lift up the sides *n q*, *r t*, *o p*, *u v*, till they stand at right angles to the surface of the plane *a b c d*, and fold over the square *u v*, *w s*, till it lies parallel to

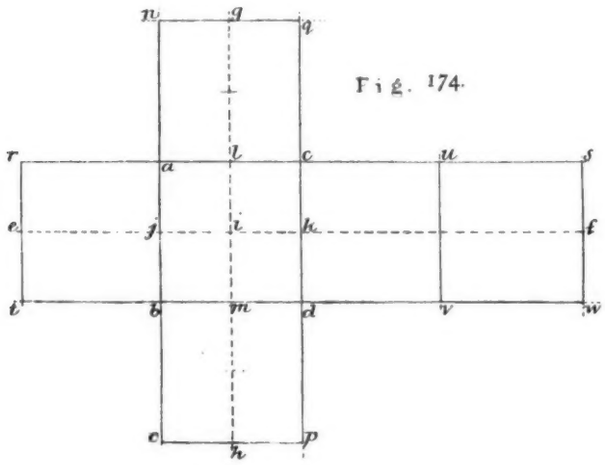


Fig. 174.

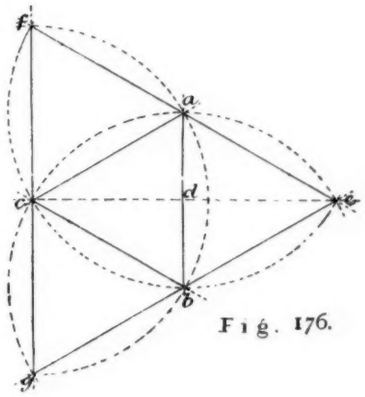


Fig. 176.

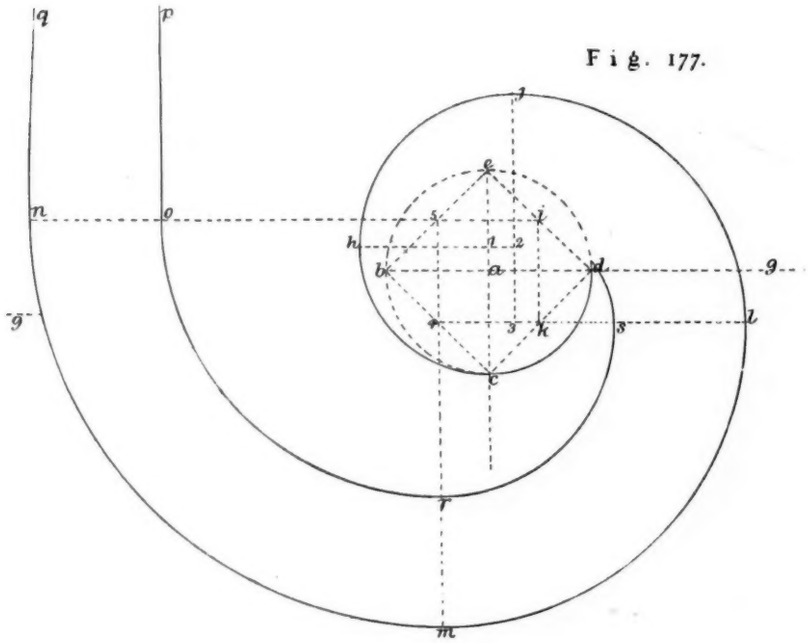
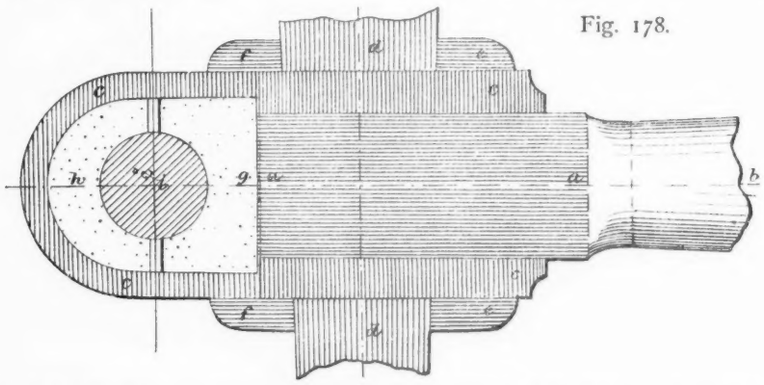


Fig. 177.

this plane; the cube will then be formed in cardboard. The square *a b c d* is called "seat of projection" of the cube.

The "Tetrahedron," and the Development of its Surfaces.—The solid illustrated in fig. 175 is bounded by four equilateral triangles. To develop the triangles which, when bent or folded over, will form the solid, proceed as follows. Let *a b*, fig. 176, be the length of the base of the triangle *a b c*, forming the seat of the projection of the tetrahedron. Divide *a b* into two equal parts in the points *d*, and draw *c d e*, and from the point *c* the line *f g* at right angles to *c e*. With the distance *a b* as radius,

Fig. 178.



and from the centres *a b*, describe the arcs cutting *c e* in *e*. With the same radius, from the points *a c*, *c b*, describe arcs cutting the lines *f g* in *f* and *g*. Join *a c*, *b e*, *b g*, and *a f*. With a sharp knife cut through the cardboard by the lines *g e*, *e f*, *f g*, and half through the cardboard by the lines *c b*, *c e*, and *a b*. Fold up the three external triangles, *b e a*, *b g c*, *c a f*; and press them inwards till the points *e f* and *g* meet, when the solid will be formed.

(45.) **Spirals, Scrolls, and Volutes, and how to describe them.** (See Notes, Nos. 8-25 and 35, pp. 126-186 and 381.)—To describe the scroll in fig. 177 draw two lines intersecting in the point *a*, as *e a c*, *g d b*; from the point *a*, with radius *a c* equal in length to half the diameter of the eye of the scroll,

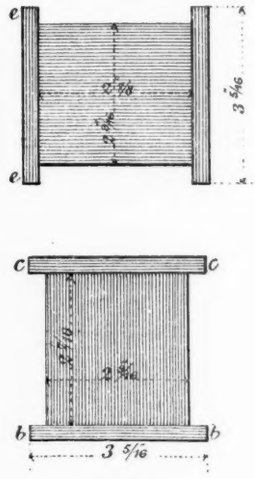


Fig. 185.

describe the circle *e b c d*, which represents the eye of the scroll. Join the ends of the diameter *e b*, *b c*, *c d*, *d e*, so as to form a diagonal or lozenge square. Divide two of the sides of this as *b c*, *d e*, on the points 4 and *i*, and draw *i* 5, 4 *k*, parallel to *b d*, and 5 4, *i k*, parallel to *e c*, thus forming a second square, 5 *i*, *k* 4, within the diagonal square *e b c d*. Divide each side into four equal parts, and draw lines as in the diagram, thus dividing the small square 5 *i k* 4 into sixteen equal-sided squares, and number certain points as given in the diagram. Then from the point 1 as a centre, with the distance 1 *c* as radius, describe the arc *c h*, cutting and terminating at the point *h* on the line 21 extended. Then from the point 2 as a centre, with the distance 2 *h* as radius, describe the arc *h j*, cutting and terminating at the point *j* on the line 32 extended; then from the point 3 as a centre, with the distance 3 *j* as radius, describe the arc *j l*, cutting and terminating at the point *l* on the line 43 *k* extended; then from the point 4 as a centre, with the distance 4 *l* as radius, describe the arc *l m*, cutting and terminating at the point *m* on the line 4 *m* extended; then from the point 5 as a centre, with the distance 5 *m* as radius,

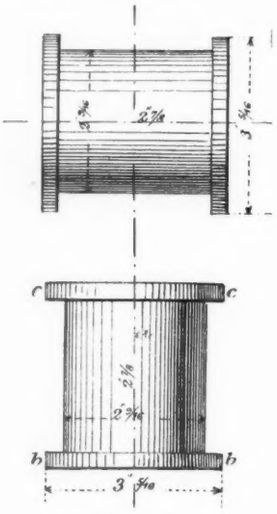


Fig. 186.

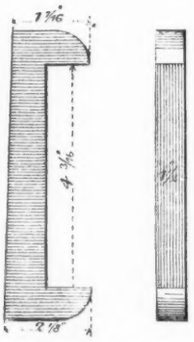


Fig. 182.

describe the arc *m n*, cutting and terminating at the point *n* on the line *i* 5 extended. Next set off on the line *n i* the distance *n o*, equal to the breadth of the rail, and draw *n q o p*. Then from the point 5 as a centre, with the distance 5 *o* as radius, describe the arc *o r*, cutting the line 4 *m* on the point *r*; then

Fig. 179.

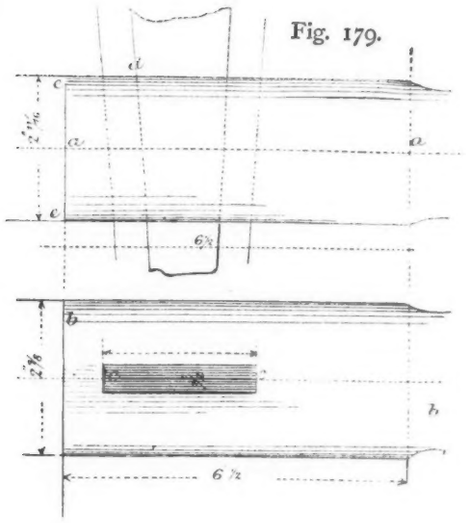


Fig. 180.

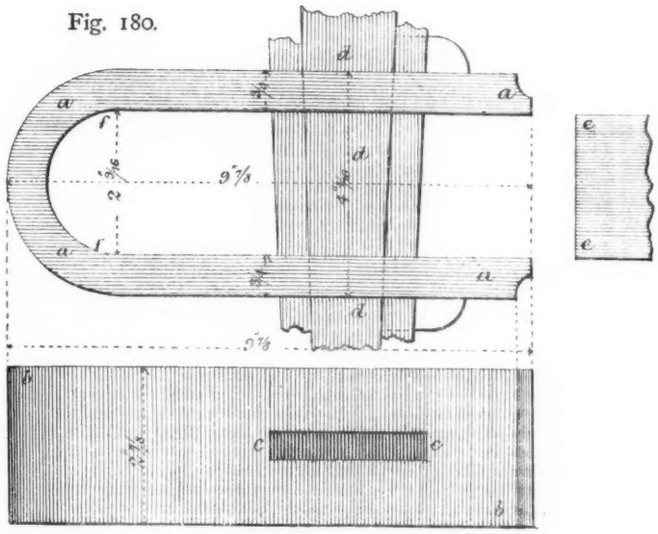


Fig. 181.

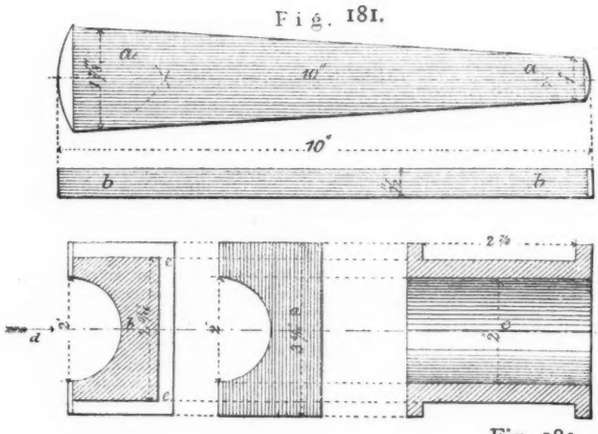


Fig. 183

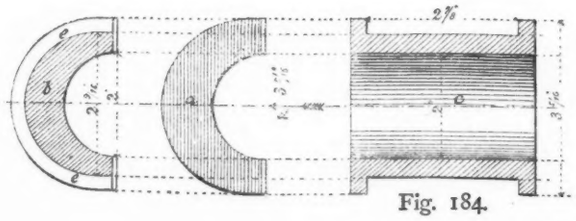


Fig. 184.

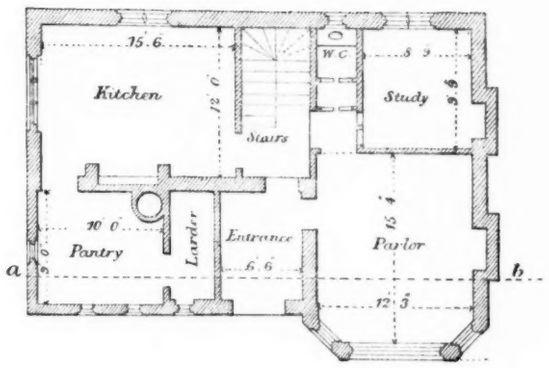


Fig. 187.

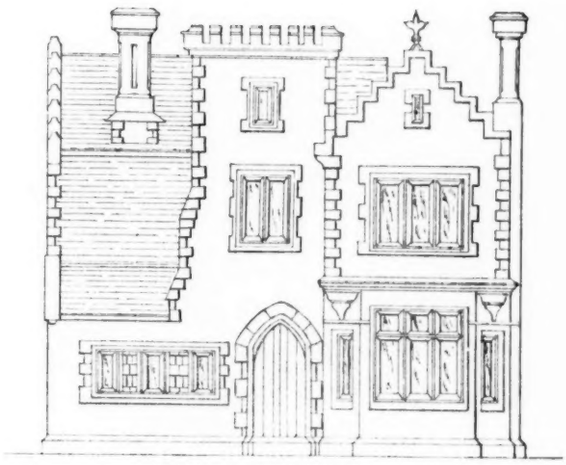


Fig. 188.

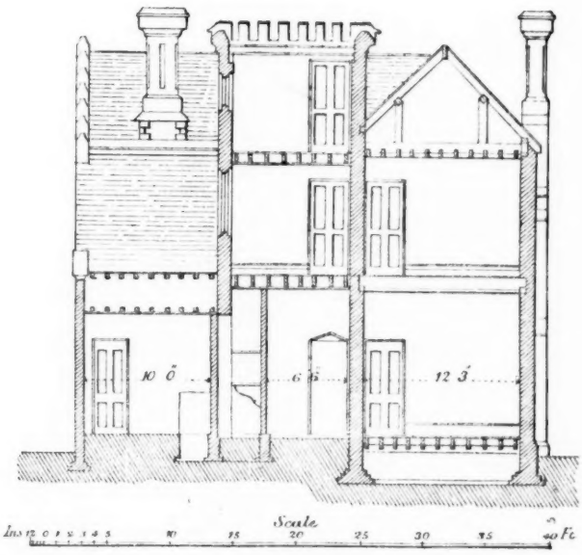


Fig. 189.

from the point 4 as a centre, with the distance 4 *r* as radius, describe the arc *r s*, cutting the point *s* in the line 4 *s*. Next from the point 3 as a centre, with the distance 3 *s* as radius, describe the arc *s d*, joining the circle *e b c d*. Finally, fill in with a full line the part of the circle *e b c d* from *c* to *d*, and the scroll is complete.

(46.) **The Student's Sketch Book of Working Drawings** (see note No. 38, p. 386.)—Second example in Section A, Mechanical, this being a "Connecting-Rod," one-third full size. In fig. 178 we give the front elevation or general view showing the connection of all the parts; *a a*, the end or "butt" of the connecting-rod *b*, which is of any determined length, a part only being shown in the drawing; *c c*, the "strap," connected to the butt by the "key" or "cottar" *d d* and "gibs" *e e* and *f f*; *g* the right-hand "brass" or "bush," *h* the left-hand ditto; *i* the section of the pin, or bars of the cross-head to which the connecting-rod is jointed. In fig. 179 we give at *a a* a front elevation of the "butt" *a a*, fig. 178, by the connecting-rod *b*; and in *b b* a plan or upper edge view of the same showing the slot or aperture *c c* cut in the same to admit the "key" or "cottar" *d d*. In fig. 180 we give at *a a* a front or side elevation of the "strap" *c c*, fig. 178; and at *b b* an edge or view of the upper side showing the slot *c c* to receive the "key" or "cottar" *d d*, *e e* is part of the butt *a a*, fig. 179, showing how it is slipped in between the ends *a a* of the strap. Fig. 181 is a front view *a a*, and edge view *b b* of the "key" or "cottar" *d d* in fig. 178. Fig. 182 gives at *a a* front and at *b b* edge view of one of the "gibs," as *e e* in fig. 178. In fig. 184 we give three different views of the brass or bush *g* in fig. 178; *a* is the front view, *b* a section showing the solid part and the flanges, and *c* is an inside view looking in the direction of the arrow *d*. Fig. 184 gives corresponding views of the brass *h* in fig. 178. In fig. 185 we give two end views of the brass *g g* and *a* in fig. 178, looking in the direction of *a* towards *i*, with the face *a a* upwards; in fig. 185 in *a*, *b b* is the lower flange, *c c* the upper corresponding to *g* in fig. 178. In fig. 185 *d* is the end view of the same brass looking in the same direction, but with the drawing in fig. 178 on edge; *e e* is the flange corresponding to the flange *g*, which would then be towards the left-hand. Fig. 186 gives corresponding end views of the brass or bush *h* in fig. 178. The various parts are put together as follows. The pin *i* is embraced with the brass *h*, then the strap *c c* is put on, so that the inner circular part *f f*, fig. 180, passes round the circular part *e e* of the brass *b* in fig. 184. Next the brass *g*, fig. 178, is slipped in between the ends *a a*, fig. 180, of the strap *c c*, fig. 178. Then the "butt" *a a* of the connecting-rod is passed in between the strap, its end *e c*, fig. 179, butting against the flat back *e e* of the brass *b*, fig. 183. The gibs *e e*, *f f*, fig. 178, are then passed into the slots *c c*, figs. 179, 180, and the key *d d*, fig. 178, inserted between them, and finally driven home.

"Section C, Architecture and Building." In fig. 187 we give "ground plan" of a cottage in the Domestic Gothic or Tudor style, in fig. 188 "front elevation," and in fig. 189 "transverse section" on the line *a b* in fig. 187; the other elevations of this will be given in the next number.

ON THE PURCHASE OF THE RAILWAYS BY THE STATE.[1]

By William Galt.

IN 1844 the Legislature considered it desirable to pass an act enabling Government to purchase, on certain specified terms, all the railways in the United Kingdom that from that time forward should be constructed. To protect, however, the interests of the shareholders, and give ample time to the nation and the Legislature to obtain sufficient experience of the working of the present system, it was enacted that twenty-one years from the passing of the act should elapse before any change should be effected, or the rights of proprietorship in any way be interfered with. The act came into operation, or, more correctly speaking, might have been brought into operation, in 1865, and the subject we have this day to consider is, whether or not it is desirable, in the interests of the nation, to carry out the object for which this act was passed.

Before we proceed, however, to consider our immediate subject, it is necessary to give a sketch of our railway legislation previous to 1844. It was not at first supposed that railways to a great extent would supersede the ordinary turnpike-roads and canals in the conveyance of passengers and merchandise, and consequently no special provision was made against such a contingency. The companies were merely bound to admit the engines and carriages of other persons on their lines, it being presumed by the Legislature that there would be no difficulty in carrying out such an arrangement, and that the public would thus derive all the benefit from competition on railways that hitherto they had been accustomed to on the common roads.

In 1839 a committee, which included among its members the late Sir Robert Peel, reported in the strongest terms that this sort of competition was not only impracticable but undesirable, and that the owners of each line must hold it as a monopoly.

"It will be found," said the report, "to be the opinion of some of the witnesses that the interests of the several companies and the public can never be at variance, and that the managers of these great establishments, acting with an enlightened view of their own interests, will always have a due regard to the general advantages of the community. A main object which the directors of a company must have in view is to obtain a good return for the capital expended, while it is the primary interest of the public that the intercourse should be regularly maintained with the greatest safety, speed, and economy. Cases have already risen in which the interests of private companies and the public have been found to be opposed to each other, and it appears probable that, in proportion as this new system shall supersede other modes of travelling, other inconvenient consequences will ensue, unless some authority be established to watch over and protect the interests of the public. The fear of a rival line may in some instances be a check on the conduct of a company, but there are few districts in which the public will have any opportunity of selection, and obvious and serious difficulties must arise of carrying this means of control into execution." Such was the opinion of Sir Robert Peel, and the committee of which he was a member, on the relative position of the companies and the public, when of course the supposition of competition on a railway by rival carriers and others had long previously passed away.

The next idea that took possession of the public mind was that by having "competing lines," as they were called, competition between the companies would necessarily follow, and that device no doubt for a time partially succeeded. These lines, many of them quite unnecessary, were constructed at a vast outlay of capital; violent competitions, by fits and starts, at exceedingly low charges, took place, but the companies soon became aware of the folly of such proceedings; amicable arrangements followed, and amalgamations into large groups, comprising some twenty or thirty companies each, dissipated the dreams for ever of those who imagined that any possible scheme could be devised by which competition among railway companies could be maintained, or the railway traffic of the country be anything else than a monopoly, in whatever hands it might be placed.

Let us now direct our attention for a moment to the Continent, and contrast the principles on which the people of Belgium established their railway system with that adopted in England. Belgium was the first of the continental kingdoms to recognize in a practical manner the good results to be derived from a well-established system of railway communication throughout the country. Lines were accordingly laid out by eminent engineers throughout the most populous districts, and constructed at the expense of the State, under the immediate control of Government. The end aimed at was, not the gain of the speculator—for there was no speculator—but the extension of the traffic and communication of the country to the utmost limits of the public capability. The project undertaken by the Government was an establishment which was intended should neither be a burden nor a source of revenue, and required merely that it should cover its own expenses, and pay Government interest on the invested capital. When the project, which afterwards became law, was introduced into the Belgian Chambers in 1834, there were not wanting advocates to recommend the course that we were pursuing in England, and leave the whole traffic of the country to what was called "competition." M. Rogier, the Prime Minister, stated in a very few words the determination which Government had come to on the subject, and the reasons for that determination. "The state of affairs," said he, "in which competition corrects the evil does not apply here; whoever holds the railway holds a monopoly, and that should only be allowed to exist in the possession of the State, subject to the responsible advisers of the Crown." Now, if a volume had been written upon the subject, it could not have more clearly expressed than in that brief sentence of the Belgian Prime Minister the subject-matter of what we are called on to discuss this day. It will, I think, be universally admitted that forty

[1] Read at an extraordinary meeting of the Society of Arts, on 13th June, 1873, the Right Hon. the Earl of Derby in the Chair.

years' experience of the working of our railway system confirm the truth of his first proposition, that the traffic on railways must be a monopoly; how far the alternative proposition that they should be in the possession of the State would be an improvement, is with us an open question.

Now, I freely admit at the outset that the advocates of this great organic change in our railway system are called on to make out an overwhelming case in support of their views, before they have any right to ask the country to adopt them. It cannot be denied that what they demand is wholly opposed to the traditional policy of this country; as much so as that of free-trade is to the commercial policy of the Continent or of the United States of America, or of our own colonies. But it does not necessarily follow that our railway system is sound because it is in accordance with our traditional policy, nor that free-trade is wrong in principle, because in almost every nation but our own the doctrine of free-trade is considered altogether fallacious. We are accustomed in this country to follow the wise policy of leaving our great industrial works to private enterprise; but, in the present case, the question at issue is, whether or not railways, which have become the high-roads of the country, belong to an exceptional class of industrial works of such a nature, that it is only when they are in the possession of the State the public can realize all the advantages which such a rapid and economical means of communication is calculated to afford.

I propose to consider this subject under the following heads:

First.—The complaints against the working of the present system, and then the benefits which the advocates of State ownership and management contend would be gained by the public if the former system were abolished and the latter substituted in its stead.

Second.—To discuss the arguments generally used in opposition to what is commonly called "Government management."

Third.—To examine the clauses containing the compulsory powers of purchase in the act of 1844, with a view to consider how far they are effective.

Fourth.—If they should be found ineffective, to discuss the probability of a voluntary agreement being come to with the companies.

Fifth.—To consider if the extension of the Irish railway system by the State might be the means of enabling the British public to come to a practical conclusion as to the desirability of the State purchasing the British railways.

Sixth, and last.—Assuming for argument's sake that it would be found desirable that the State should become the owner of all the railways in the United Kingdom, and that they cannot be obtained on what the Legislature should consider equitable terms, what resource, if any, would be left to the Legislature?

The two first divisions have reference to the theory of State purchase, and the four latter to its practical application.

Now, if I fully understand the object of this meeting, I think our discussion should be confined to those subjects I have specified, and that we should not wander into extraneous matters. The theory of State purchase may possibly be shown to be unimpeachable, and the arguments advanced in its support unanswerable; but, on the other hand, it may be proved that the enormous difficulties that would attend such a gigantic operation are of such a nature as to render hopeless any attempt to overcome them. Our object is to discuss the principles of political economy, and statistics in reference to the ownership and management of railways alone, and above all things to endeavour to obtain figures and calculations as nearly accurate as possible, as regards the sum for which the railways could be purchased; for that matter is quite as important as the soundness of the theory of purchase. It is, no doubt, true that political and social relations enter largely into the general question, but I trust that you will agree with me that this is neither the time nor the place to entertain such matters. Above all, I must strongly deprecate attacks being made on the management, and consequently the directors and managers of our railways. There is not, I believe, a more able body of men in the kingdom than the managers of our great railway companies, and speaking of them as a body, I have no doubt they are desirous to meet the wishes of the public, so far as that is consistent with the interests of their employers. They are quite capable of defending themselves if attacked, and if charges of alleged mismanagement, in regard to accidents or other matters of complaint—which will happen under the best management—are permitted, rejoinders, of course, must follow, the discussion will be turned from its legitimate object, and we shall altogether fail to accomplish the object for which we are here assembled. We shall now proceed with our subject.

In 1843 there were 2,200 miles of railway completed, at an expenditure of about 90 millions, and even at that early period of our railway history great dissatisfaction existed in the public mind as regards railway management. "The *laissez faire* system," said Mr. Porter, in his "Progress of the Nation," "which is pursued in this country, to such an extent that it has become an axiom with the Government to undertake nothing, and to interfere with nothing which can be accomplished by private or individual enterprise, or by the associated means of private parties, has been pregnant with great loss and inconvenience to the country in carrying forward the railway system. Perhaps there never was an occasion in which the Government with equal propriety could have interfered to reconcile the conflicting interests involved, and to prevent public injury arising from the false steps so likely to be made at first in bringing about a total revolution in the internal communication of the country."

It was at this time—in 1843—that, so far as I am aware, the idea was first mooted that the railways should be purchased by the State, and be managed under the direct supervision of Government. A few individuals, of a rather speculative turn of mind, and having the example of the working of the Belgian system before them, thought that it was not too late to retrace our steps, and adopt that of Belgium, by the State purchase of the railways. These gentlemen had a great deal of zeal, but very little practical knowledge of the subject on which they undertook to enlighten the country. They formed, of course, a railway reform association, made speeches generally to each other, held meetings which, I am afraid, very few attended, and issued tracts and pamphlets by the score to all whom they considered should be instructed on railway management. Their programme was very bold and decided. Government should at once pass an Act without asking the directors' or shareholders' leave or license, take the railways into their own hands, pay the shareholders the market price of the day, lower the third-class fares to half-a-farthing a mile, and every other class in the same proportion; and so the association struggled on for about a year, until Government determined to deal practically with the matter, and their brief existence came to a close.

There was considerable anxiety manifested in the railway world in the early part of 1844, when it became rumoured that Government intended to introduce a sweeping measure in reference to the purchase of the railways. The expediency and policy of such a prospect was much discussed in the press, and then, as now, opinion was much divided on the subject. The "Quarterly Review" of April of that year had a powerful article on railway management, in which it truly and forcibly alluded to the Imperial dimensions the question would one day assume, and the manner in which the writer believed it would have to be dealt with. After summing up all the arguments in favour of Government purchase, the writer thus concluded:—"It is impossible not to see that the system, by developing itself to such an extent, is penetrating all districts, superseding all other communications, affecting every species of public and private interest, and acting as the life-blood arteries of the empire, so as to render it probable almost to certainty that the time must come when this great public trust can no longer be left to the management of private companies scattered over the face of the country. In truth, it seems only a question of time; railways must be made subject to some unity of management, and, through whatever intermediate process it may pass, that management must finally be vested in the Government of the country."

Now, what was the first popular outcry in the country against the companies? It was the alleged ill-treatment of the humbler class of passengers, and I cannot better illustrate this complaint than by reading a leading article in the "Times," which appeared in December, 1842. It was as follows:—"We have received communications from several correspondents, imploring us to maintain an advocacy for the poorer class of railway travellers, who have to avail themselves of the stinted accommodation afforded by the leading lines, and desire us to urge the necessity of more comfort and facility in their transit than they at present enjoy. It would appear, from the facts stated in the several letters received, that little choice exists in one more than another, and that all the great lines are as parsimonious as they possibly can be in providing comfort or convenience for those having the misfortune to travel in third-class conveyances. The manner in which the Great Western treats this class of passengers is described as worse than any other pursued, the only trains by which they forward them being used for the transit of coals, cattle, and merchandise of all descriptions. For instance, it is stated that a third-class passenger leaves Paddington in an open carriage, no difference being made to counteract wind or weather, at half-past four in the depth of winter. When he arrives at Swindon he is detained upwards of an hour, and at last gets to Bristol, if the train keeps its time, in nine and a-half hours, while the first and second-class carriages make the journey in less than half the time. If a third-class passenger wish to go on to Taunton from any place east of Bristol, it is alleged to be still more inconvenient, since he is detained from four to five hours in Bristol, and is kept on the road, at a moderate calculation, from fourteen to sixteen hours; whereas, on the other hand,

first and second-class passengers arrive at the same destination in six and a-half hours. These are strong statements, and, unless satisfactorily explained away, must sooner or later come within the managerial scope of the Board of Trade, the authorities of which body would do well to see that fair and adequate provision is made by all the railway companies for the conveyance of the poorer classes during seasonable hours of the day. Railway directors have at present the exercise of too much irresponsible power, and therefore imagine they can deal with the public as they choose. They must, however, be mindful not to carry it beyond proper bounds; for though much good may have been achieved by the construction and successful competition of intercourse by means of this system of communication, it remains to be seen what will be the actual results of this description of management, should it, without some superintending power, be left entirely to the judgment of the persons who have the whole exercise of this power. It may possibly prove a useful hint to have said this much on the subject, without pressing more severely on the attention of the several railway boards the necessity existing for some amelioration of the plan at present adopted in the conveyance of third-class passengers; for, regarding them in the light of national improvements, raised on the foundation of the nation's wealth, they must be considered as intended to furnish a comparative convenience to one class of the public as well as the other." Such was the article in the "Times," and it fairly represented the feelings of the entire nation on the subject.

Let us, however, look now to the other side of the question. If the shareholders in the railway companies professed to be a body of philanthropists that had constructed the railways for the public benefit, quite regardless of profit, and whose special vocation was to provide for the travelling wants at fares which they did not consider remunerative, nothing could be more reasonable than this appeal to their feelings; but the companies made no pretensions of the kind, they were composed of hard-headed men of business, who had made a contract with the State to provide for the wants of the public—a duty which the latter had declined to undertake—and the public, consequently, had no right to appeal to them *ad misericordiam*, and beg them to do something not in the contract, and threaten them with pains and penalties—like the beggar in "Gil Blas," when he presented a gun in demanding alms—if their prayers, or rather their demands, were not complied with. What right could be urged in favour of such a demand? The companies' contract was to carry passengers at threepence a mile, and they had, of course, a right to enforce that charge on every passenger who travelled on the railways; but they were actually, at the time when this piteous appeal was made to their charity and their fears, carrying those passengers at less than half the price they were authorized by Act of Parliament to charge.

The next grievance complained of was that first and second-class passengers were charged high and arbitrary fares. It was at one time a matter of some nicety, and gave considerable anxiety to a board of directors and their manager to fix the fares, when their line was opened, at the exact point that would best pay. That knowledge was only to be gained by adopting a sliding scale, and by going through the process of alternately raising and lowering their fares till those that would pay best were ascertained. Now the difference in profit to a company between high and low fares, as we shall hereafter see, is not much. On some railways it is more profitable for companies to carry many at low fares, than the comparatively few at high fares; on other railways it is just the contrary; all depends on the nature of the traffic and the localities through which a line may pass. With railways that paid fair dividends the changes in fares were not very great, seldom exceeding ten or twenty per cent.; but it was very different with the unfortunate class that paid very low dividends. The directors, attributing, perhaps, their want of success to not having charged high fares, made the most extreme and sudden changes in order to discover the best paying rates, and the tariff would be raised thirty, fifty, or one hundred per cent., as the case might be; or should they have been of opinion that the original fares were too high, reductions would be made accordingly; however, all these changes made but comparatively little difference in the profits of the companies—as fares increased passengers decreased, and as fares decreased passengers increased, though not in exact proportion. By this means each company was able to ascertain and fix the best tariff for its own interests, and as a matter of course, without any regard to the interests of the public. Nevertheless, these changes in an upward direction caused great dissatisfaction, although the proceedings of the directors were perfectly legal. As a general rule, however, throughout the country the directors came to the conclusion that what was called "moderate fares" paid best, and that two-pence, three-halfpence, and one penny per mile, for the several classes, yielded the largest profit.

I may notice here incidentally, that there existed at that time the erroneous belief that charges in this country could never be reduced to a low scale on account of the great cost of our railways. In reviewing a work of mine, published in 1843, advocating the adoption of the Belgian tariff, the "Quarterly Review" observed:—"Let us look at the expense of making the respective lines, as stated in Mr. Laing's Report:—

Cost of Construction per Mile.

	£
Average of the 71 railways of England .	34,360
Average of Belgium	17,120

Will any one pretend to say that a thing which costs £40,000 ought to be furnished in detail to the public as cheap as if it had cost only £17,000? But is it not curious to find that the average expenses of the Belgian lines turns out to be so exactly the one-half of the average of the British lines as are the fares on the railways?" It is scarcely necessary to observe that not the most remote connection exists between the charges that will pay best on a railway and the cost of the line. The fact of a railway costing £10,000, or £100,000, or half a million per mile, has not the slightest consideration with the directors in fixing their charges. If in some cases a company whose line cost £100,000 per mile would make as high charges as on other lines that only cost £10,000 a mile, they would soon be ruined.

What, then, is the present complaint against our railway system, as regards the conveyance of passengers? It is this: that the public do not derive the full benefit from the existing low rate at which they can be conveyed by railway. The cost of conveying passengers, under favourable circumstances, is less than the twentieth part of the cost of conveyance on ordinary turnpike roads. It is no part of the duty of directors to consider if it would be for the public advantage to carry the few at high fares, or the many at low fares; not only so, but they would be departing entirely from their duty if they allowed themselves for a moment to be influenced by such a consideration, to the detriment of their shareholders. A railway company is simply a trading company, authorized by law to make certain charges to the public for specified work to be done, and the duty of the directors towards their shareholders is, while keeping within the limits of the law, to obtain the largest return for the invested capital. With the public loss or gain they have nothing to do. Under such a system, with a monopoly of the conveyance of passengers throughout the country, it must be obvious that the national interests are entirely subservient to private interests, and until the system is abolished the evils which it entails must necessarily be continued.

The working of our railway system as regards the conveyance of merchandise, is bitterly complained of throughout the whole of the country by almost every class engaged in mercantile transactions. The main charges preferred against the companies are —1st. Excessive charges compared with the cost of conveyance. 2nd. Arbitrary and exorbitant rates imposed upon some towns in comparison with others. 3rd. Refusing to separate the rates for carriage from terminal charges. 4th. The great injury to the trade and commerce of the country from the want of unity of management. 5th. The refusal to publish a list of charges from station to station of the several classes of goods. The evidence taken before the joint committee last session in reference to the proposed amalgamation of the London and North-Western and Lancashire and Yorkshire Company abundantly bear out all the charges, and is published in a very large volume. It is of course impossible for me to enter into any details as to evidence. I shall only refer to the great port of Liverpool as a typical case; and a score of other towns similarly circumstanced might be named.

The Liverpool Chamber of Commerce, composed of "bankers, merchants, brokers, shipowners, and others engaged in commerce," forwarded to the Prime Minister, in March last year, a memorial to the following purport:—

They stated that for many years they had been giving their attention to the question of the excessive and especially of the unequal rates levied by the railway companies on the traffic to and from Liverpool, as compared with the rates charged for the same goods for similar distances to and from other parts. They state that the trade of Liverpool is essentially a transit trade, the imports for the most part not being consumed in it, but distributed mainly by railways over the country, and that the exports are for the most part not contributed by Liverpool, but are sent for shipment from Yorkshire, Staffordshire, Lancashire, and other places, and declare that a system which obstructs the inland carriage of goods to and from Liverpool by the imposition of heavy tolls and charges must tend to drive the trade to other places more favourably located, and must prove highly injurious to the port of Liverpool.

The memorialists further pointed out that this was no idle fear

on their part, for that already, in consequence of these differential charges, a considerable amount of traffic had been diverted from Liverpool, to the injury alike of the individual trader and the port, and that the extra charges are so imposed as to force the traffic out of its natural channels, and enable the railway companies to offer a bounty to divert it into channels through which it would not otherwise flow.

The result of this policy, the memorialists went on to state, is that consumers of imports and producers of exports in the great and populous district of which Liverpool is the natural maritime centre are burdened with a tax and restricted in their trade in order that unprofitable extensions of railways in other directions may be made to pay; and the memorialists contended that such a system was an injustice to the consumer, an injury to trade, and a departure from those principles of public policy on which all concessions to railway companies should be based.

The memorialists further stated that they considered this question of the amalgamation of the London and North-Western with the Lancashire and Yorkshire Company as one of the most vital and important to which their attention had ever been directed, that in their opinion the magnitude of the interests touched by the proposed amalgamation of the two great carrying companies referred to divested the Bill brought into the Commons House of Parliament for that purpose of its private character, and gave it a claim to prominent consideration amongst the public measures of the session; and that a thorough revision should take place of the terms on which the railway system is allowed to enjoy a monopoly so injurious to the traffic of the country.

The result of that and similar memorials addressed to the Prime Minister is well known. A joint committee of the leading members of both Houses was appointed. They sat nearly the whole of last session, took a vast amount of evidence, and ultimately came to the conclusion, *inter alia*, "that it was impossible to lay down any general rules determining the limits or the character of future amalgamations." They drew up a most able and valuable report, giving a very full history of our railway legislation, and recommended the appointment of a Board "to enforce the harmony, working, and development of the present railway and canal systems." An Act of Parliament has been passed in accordance with the recommendation of the committee, and the Board has been appointed. So far as their powers go, this Board will, no doubt, be of some use. But the main grievances referred to in the memorial are untouched, viz., high rates and differential charges, as the committee could not recommend Acts of Parliament, in which the companies were interested, to be altered or partially repealed without their assent, which of course they refused to give. The Bill for amalgamation, as you all know, was unanimously thrown out by the committee to whom it was referred a few weeks since, without calling a single witness opposed to it. The committee, no doubt, considered that it would be better to forego for the present all the vast advantages which the extension of amalgamations is calculated to confer on the public, rather than create an enormous monopoly which would confer on the company uncontrolled power, and yield them increased profits, without the slightest guarantee that Liverpool, and other great towns similarly situated, not only might receive no benefit whatever from the change, but be liable to have their position made still worse by the united power of the two companies amalgamated into one. But, passing all this by, are the companies liable to censure for the course they adopted before the joint committee? Was it from any animosity they felt against the town of Liverpool, or a desire to injure its trade? No such imputation was ever made against the directors, all of whom are men of the highest position and character, and several leading merchants in the town, deeply interested in the extension of its trade and commerce. Nor was it from private individual interests; no such imputation was made against any member of their body. They acted merely as other trading companies would act under similar circumstances. The law gave them the right to impose a heavy tax on Liverpool and other towns similarly situated, by doubling or trebling the rates in their district; such impositions in their opinion yielded a profit to the company, and consequently their duty to the shareholders required them to maintain their rights. Now, if the companies had been content to let the matter rest on that plain, common sense footing, I must confess that I consider their vindication would be complete; but some of their advocates, with more zeal than knowledge, contend that their policy confers a great benefit on the country generally, "by giving protection and encouragement through low rates to distant towns, whereby they are able successfully to compete with other towns more favourably situated, greatly to the public advantage." There always are two ways of stating a proposition, and the Liverpool merchants would probably formulate the same proposition something like this—"The railway companies carry merchandise at rates which yield them good profits to Lancashire, Yorkshire, and Staffordshire from very distant towns, but we, who are favourably situated for communication with these surrounding districts, are charged three times the ordinary rate at which merchandise is carried to and from other towns; thus our trade is greatly injured, and as these extra charges necessarily fall upon the consumer, the public in consequence heavily suffer."

A very intelligent witness from Liverpool, Mr. C. Clark, after describing the manifold grievances under which the town suffers, and in reference to one especially, thus sums the matter up:—"The idea, I believe, at the bottom of it all is this—there are three great places which compete for our sugar traffic—three great centres of the refining interest; one at Bristol, the other at Liverpool, and the third at Greenock. As regards Liverpool, Providence has put us considerably nearer most of the large towns where sugar is consumed than is the case with Greenock and Bristol, and I think the railway companies have got an idea that it is their mission to redress this inequality, ordained by Providence, by making the same rate, or pretty nearly the same rate, for the short distance as they make for the long one, to deprive the consumers of sugar of the advantage which they would naturally derive from being able to obtain it from the place which is nearest to them, and where sugar could be most cheaply carried. I really believe that that theory is at the bottom of it." Without exactly concurring in Mr. Clark's opinion as to the motive which influences the companies in dealing with the several towns so differently situated, there can be no question that they are carrying out "protection" in its worst form. The "protection" which was part of our policy in days gone by was directed against the "foreigner," who threatened to bring cheap corn into the country, but the "protection" in the present case is made use of against our own countrymen, and in a manner equally injurious to the producer and to the consumer. In Liverpool there are perhaps fifty merchants who compete with each other for the trade of these districts, and the fallacy that lurks at the bottom of the company theory is that there is only one trader there, who has a monopoly of all the traffic.

To illustrate this more clearly, let us put a hypothetical case. Suppose that extensive coal-fields were discovered within some twenty miles of London, of good quality and sufficient extent to supply all the inhabitants with abundance of fuel; there would, no doubt, be rejoicings at the prospect of the great reduction in price that would naturally be expected from such a supply so close at hand. Paterfamilias would calculate that as the carriage of coal from the North costs seven shillings a ton, the six shillings saved would go into his pocket, but Paterfamilias would be grievously disappointed; the same protection that is now given to the districts about Liverpool would be extended to London, competition would be maintained by charging to the coal market the same carriage for the twenty miles as the two hundred, and thus the public would derive no benefit by the discovery.

Among the remedies for railway grievances suggested by several of the witnesses examined before the joint committee, a limitation of the companies' dividends appeared to find most favour. In the minds of many people there seems to exist a connection between moderate dividends and moderate charges, and they believe that if companies were restrained from paying dividends beyond a certain percentage on their capital the public would have the benefit of the surplus. It was recommended by these gentlemen that in order to prevent the companies from avoiding reduction of rates by not declaring the whole of their actual profit as dividends, that it should be the duty of a Government department intrusted with the revision to see that the actual profits, however employed, did not exceed the legal amount. That would, in fact, give the Government officials the complete control of the expenditure, with the right to decide how expenses should be charged as between revenue and capital. This, to be effective, must extend to every department of a company's business, and give Government a complete control over the expenditure. Such an arrangement would be altogether inadmissible. It is no part of the duty of a Government to employ its officers in managing the finances of a company, or in otherwise interfering with their business. But as regards railway companies, from the time they obtained their first act till the other day, when a commission was appointed to regulate their affairs, committee has been appointed after committee, and commission after commission, to regulate railway companies. "The cry is still they come." There has been a constant interference on the part of the Legislature, urged on by a dissatisfied public, to an extent that never has been thought necessary with any other class of joint stock companies; but if the companies are discharging a delegated trust without any of the moral responsibilities that should attach to the office—if their position is such that in giving to the public the full benefit that might be derived from low fares and equitable rates on

railways, they would sacrifice to a greater or less extent the interests of their shareholders, it is surely time for the nation to consider the desirability of taking back the railways into its own hands, and it is for us now to consider what in such case those benefits would be.

As railways have superseded to a great extent the highways of the country, it will not, I presume, be questioned by any that the greatest possible facility of transit for passengers and goods should be afforded to the public, and that the fares for passengers and charges for merchandise should be reduced to the lowest possible rate consistent with the payment of working expenses and interest on the capital invested in the construction of the lines. I have endeavoured to show that under the present system the public are deprived of many benefits it otherwise might enjoy, and we have now to consider in what respects the transfer of the railways to the State would be advantageous.

I directed your attention a little time ago to the very important fact that within certain limits, and so far as our experience goes, there exists very little difference in the dividends of a company, whatever may be the fares adopted within these limits. I was examined before the committee of 1844, and gave examples of about a dozen cases in which companies in search of the best paying fares made all sorts of experiments, varying from ¾*d.* to 3*d.* a mile for first-class, ½*d.* to 2*d.* for second, and ¼*d.* to 1*d.* for third, and that in no case would the difference in money received amount to one per cent. on the dividends. In later times, till within the last ten or fifteen years, we have had some long and violent contests between some of the great companies, in which they suffered considerably, but I only know one case in which the dividend has decreased to the extent of 1¼ per cent. During the summer of 1857 we had the London and North-Western and the Great Northern Companies carrying first and second-class passengers between London and Manchester, giving return tickets, and allowing four clear days in Manchester; the distance was 400 miles, and the fares 7*s.* 6*d.* and 5*s.*, equal to 3*s.* 9*d.* and 2*s.* 6*d.* each way. These trains must have interfered to a great extent with the general passenger traffic of both the companies to all the large towns in the North of England. Although the excursion traffic to Manchester paid *per se* exceedingly well, yet it was said that by its interference with their other traffic the companies lost fully one per cent. dividend.

Let us stop for a moment to inquire into the cost of these excursion trains. They were, it is needless to say, well filled, and carried, I have been told, on an average, about six hundred passengers—say two hundred first and four hundred second-class passengers, the fares for the double trip amounting to £175. The cost of a train that year per mile was two shillings and sevenpence. The whole expense of each train, both the direct expense and its proportionate expense for management, came to fifty guineas, leaving a profit of about 250 per cent. on the conveyance of passengers by each train. On ordinary trains the profit is about 100 per cent., which may not amount to as much as to pay a dividend of 5 per cent., yet we see that in this case the fares for the passengers were, for first-class, each hundred miles one shilling and ninepence, and for second-class, in carriages comfortably cushioned, one shilling and twopence, or a penny for seven miles! Many other cases might be quoted of long contests between companies for passenger traffic at very low fares, in which all suffered more or less. One of the most memorable of these was the contest about twenty years ago between the Caledonian and the Edinburgh and Glasgow Companies, in which the latter suddenly reduced their fares between Edinburgh and Glasgow for the three classes from 8*s.*, 6*s.* and 4*s.*, to 1*s.*, 9*d.* and 6*d.* This foolish contest was continued for a year and a-half, and cost the Edinburgh and Glasgow Company nearly 1½ per cent. in their dividends.

It is scarcely necessary to say that to ordinary traffic such low fares do not apply; they only show the very low rate at which passengers can be conveyed, and the comparatively little difference in profit between high and low fares.

Let us see how this knowledge would be practically applied if the railways were in the possession of the State. We will assume that the Legislature wished to reduce the fares one-half. What would be the extra expense for the conveyance of the increased number of passengers? Mr. Stewart, who was for twenty years secretary to the London and North-Western Company, gave very valuable evidence before the Royal Commission in 1865, regarding traffic arrangements. He said that the passenger trains were not on an average more than one-third filled—two-thirds of the seats being empty; and that the additional expense to the company would be very trifling if all the seats were filled. Indeed, it must be obvious that whether an omnibus carries three passengers or six, the additional expense is very small, and so with a train that is only partially filled. Under these circumstances the additional expense would be very trifling. But a company would naturally prefer carrying three passengers at sixpence each to six at threepence each, and that fact makes the difference in position between Government and the companies.

The witnesses examined before the Royal Commission and the joint committee agree that there would be an enormous saving in working expenses by the amalgamation of the companies. Mr. Stewart stated that if the whole traffic of the country was worked harmoniously together there would be a saving of 20 per cent. in the working expenses—in the London and North-Western they would be able to save £600,000 a-year. Other competent witnesses calculated it at 25 per cent.

In addition to this great saving, if the railways were bought at a fair price, and the shareholders were paid in Government stock, there would be a very large profit to the State, inasmuch as a £100 railway share paying 3 per cent. is worth only £60, but Government stock paying the same interest is worth £92. That is a matter, however, to be discussed when we come to the act of 1844, and in the meantime it is as well not to count the chickens before they are hatched, or to estimate yet the profit to be derived from the purchase.

It would be almost impossible to over-estimate the value of the boon that would be conferred on the mercantile community by the abolition of those heavy grievances of which they complain, and of which we have such abundant testimony in the evidence given before the joint committee. The establishment also of a low, and to some extent uniform tariff, for parcels and packages throughout the kingdom, somewhat similar in principle to that of the Post Office, would also be of the greatest advantage to the country.

Gentlemen connected with railways could give us very useful practical information in regard to the increase of passengers that might be expected, assuming that the fares were reduced to one-half their present amount, and what loss they would calculate on if their respective companies made that reduction. Would it be a permanent loss or temporary, and to what extent would it affect the value of their property?

As regards what is called "Government management," that of the railways, like the telegraphs, I should imagine, would undergo little change. There would, no doubt, be a board, or commission, or council, whatever the name might be, composed of a few of the leading directors and managers of our great companies, who might feel inclined to accept such an office, presided over by a responsible minister. Why such a board should not well and ably manage the railway property of the kingdom I am unable to conceive. The gentlemen who would undertake the office, instead of spending half their time, as their duty calls on them to do now, in concocting schemes of attack on or defence against their neighbours, would be able to devote that time to a much better purpose in concerting measures with their old opponents, and extending the trade and commerce of the country by reducing charges, and, so far as possible, equalizing rates, and thereby satisfy all classes of the community. Or the railways, amalgamated into one system, might be managed under the direction of a board somewhat similar in its constitution to that of the joint committee of last year. On that committee were men of the highest administrative talent, well versed in the management of railways.

The political bearing of the question I don't think we are called on to discuss. That we may leave to others. Should the railways ever be purchased by the state, we may rest quite assured that the country and parliament will take good care to settle it on such a basis as to deprive it of all political significance.

We have now to consider the act of 1844. It is not generally known that this act was passed after encountering the most violent opposition from the railway companies, who opposed the bill in every stage of its progress through parliament; and when it ultimately became an act it was quite a different measure from that originally introduced by Mr. Gladstone. The object of the companies was to render the bill totally inefficient for the purpose intended, and accordingly they put forward Captain Laws, then manager of the Lancashire and Yorkshire Railway, and a most able man, as a witness before the committee, and he ultimately succeeded in having everything pretty well his own way. His recommendation was that the companies should have "a sum equal to 25 years' purchase on their annual divisible profits, estimated on the average of the then next preceding years, but if a company should be of opinion that the said rate of 25 years' purchase is an inadequate rate of purchase of such railway, the company shall be entitled to require that the rate of purchase, instead of being calculated on such average rate of profit, shall be taken at a valuation, to be determined, in case of difference, by arbitration." In this short extract I have embodied the several clauses bearing on the purchase of the railways, and by the interpretation of these clauses is to be determined the manner in which the value of railway property is to be assessed, and the payment which the companies, in the event of

purchase, have a right to demand. I may, perhaps, mention here that I was examined as a witness before the committee, and, at their desire, furnished them with a return of the then existing railways, and the cost of each, with their market value, so far as that could be ascertained, as many of them were not finished or quoted in the "Share List." I divided them into two classes. The first contained all the principal railways in the kingdom; they were forty in number, they had cost £59,630,000, and their market value was £76,734,000. The second list contained all the railways in course of construction, and nearly completed, and cost then £8,160,000, and their value was £11,613,000. So that all the capital at that time invested in railways amounted to £67,790,000, and its market value might be taken at £88,347,000. In the course of examination before the committee, I gave it as my opinion that the market value of the railways, whether to become the property of the state then or at any future time, must form the basis on which the terms of purchase should be settled. The committee, however, were not of that opinion.

1st. We shall now consider the terms of purchase by which the state is to purchase a property that has cost nearly £600,000,000. When the act of 1844 was passed, consols were at par, and railway property was worth in the market twenty-three years' purchase. In recommending twenty-five years' purchase on the average dividends, the committee, no doubt, intended that the companies should have a bonus of 10 per cent. on the market price, but at that time Government stock was exceptionally high, and railway stock was in the same position. When Government stock fell, railway stock naturally fell with it to its normal average rate of twenty years' purchase, and assuming the principle of valuation to be correct, the companies would receive 25 per cent. instead of 10 per cent. above the value of their property. 2nd. Assuming that the value of the property could be estimated by the profits alone, extending the average over three years would introduce a disturbing element, and make the calculations utterly useless—a railway, for instance, that for the three preceding years had been increasing in value, and had paid each year respectively, three, four, and five per cent. would only be paid at the rate of four per cent., although at the time of purchase it would be paying five per cent.; and on the other hand, a railway that had in the three preceding years been decreasing in value, and paying five, four, and three per cent., would be considered of the same value—that is, two railways, one paying five and the other three per cent., the shareholders of each would each be paid the same price! 3rd. The act says that the companies shall be paid twenty-five years' purchase on "the divisible profits," and the general opinion is that "divisible profits" is only another term for dividends, but that is a great mistake; the strict meaning of "divisible profits" is the surplus a company has in hand after paying its working expenses; but before the ordinary shareholders receive their dividend all other charges must be first paid, guaranteed stock, preferential stock, debenture stock, and loans, on all of which the interest or dividends must be paid at present out of the "divisible profits." Now poor companies, with bad credit and a narrow surplus, must, on loans especially, pay a very high, and in many cases exorbitant rate of interest, which necessarily keeps their dividends very low, but as original shareholders would have all the benefit of the twenty-five years' purchase on the divisible profits, many companies would be paid at the rate of three or four per cent. out of their profits, who never as shareholders received half that percentage in dividends. 4th. The theory that the value of railways, or, indeed, any other kind of property, can be estimated by the interest or dividend which it pays, is altogether erroneous, although it is a very material element in the calculation; but the intrinsic value of the stock of two railways may be just as different in credit, and consequently in value, as the Government stock of two countries. It would be a very easy matter to confirm the truth of this statement by a reference to the share lists, showing the position of the several companies, but that, of course, I am not going to do. There is nothing I have stated on this subject but every gentleman present connected with railways is as well acquainted with as I am or better; but it is not so with the general public, who are under the impression that there exists an act of parliament by which Government, with the assent of the legislature, can purchase, on equitable terms, the railways of the country, and that there exists no difficulty with the shareholders.

But, it may be asked, what reason can be assigned for the proceedings of railway companies so that, with the perfect knowledge that the scheme of purchase was utterly worthless and could never be carried into effect, their representative, Captain Laws, not only acquiesced in it but actually suggested it? The answer is obvious. The railway directors, as I have before stated, were bitterly opposed to any measure that, either at the time or prospectively, could in any way interfere with their monopoly, and they were enraged to the last degree when not only that was threatened, but a law was about to be passed which might take that monopoly eventually out of their hands. They knew that it was impossible to successfully oppose the bill and prevent an act being passed, and they considered that the wisest policy—and they were wise in their generation—was apparently to acquiesce in the inevitable, but at the same time so concert their plans that the object for which the bill was to pass could not be effected. Lest, however, it should be supposed that I have in any way exaggerated the violent opposition the Government had in the first instance to encounter from the railway interest, permit me to read a short extract from the close of Mr. Gladstone's speech in moving the second reading of the bill:—"I do not," said he, "shrink from the contest. This bill has been represented as an attack on railway property. I contend that this measure, so far from being a measure of violence of an extreme or doubtful character, is a measure of the utmost importance; and that the option of revision or purchase is characterized by the utmost temperance and moderation, and feeling that we have right and justice on our side, I say that, although the railway companies are powerful, I do not think they have mounted so high, or that parliament has yet sunk so low, as that at their bidding you shall refuse your sanction to this bill."

The royal commission, in their report of 1867, and the joint committee in their report of last year, state that the railways cannot be purchased under the act of 1844, and it may one day be worth considering if the market price can, with justice to both parties, be made the standard of value. Even if an act had been passed authorizing Government to take the railways at their market price previous to the time of purchase, with whatever bonus the legislature might have thought proper to add, other matters besides determining the market value of the shares would have been necessary to provide for; the books of the companies must have been examined, and it should also be ascertained if the prices quoted were genuine, and not the result of stock-jobbing operations.

How an act could now be framed to meet the necessities of such a case we need not discuss, for the companies would protest against any act being passed that would supersede the act of 1844, on the faith of which they would assert they invested their capital. Now, what are the words of one clause in the act?—"It shall be lawful for the company, if they shall be of opinion that the said rate of twenty-five years' purchase of the said average profits is an inadequate rate of purchase of such railway, reference being had to the prospects thereof, to require that the rate of purchase, instead of being calculated upon such average rate of profit, shall be taken at a valuation, to be determined in case of difference by arbitration." We have heard something of late years about "consequential damages," and now we shall learn for the first time what is meant by the term "consequential profits," and the amount at which they might be assessed. It would be impossible under this act for Government to purchase a single railway with the knowledge at the time of purchase of the sum that ultimately they might be called on to pay, as each company, in addition to the twenty-five years' purchase of the profits, would, of course, make a large demand for their "prospects." So we may dismiss entirely any idea of compulsory purchase.

Is there any probability of the companies being willing to accept moderate terms for their property? The discussions that have recently taken place on the subject afford good grounds for forming an opinion of what their demands would be.

Taking the returns of 1871—the principle is precisely the same whether applied to the figures of that year or to the larger figures of 1872—it is seen that the railways cost £553,000,000, of which sum £323,000,000 is debenture and preference stock, and £230,000,000 ordinary stock, and that the sum distributed in profits that year was £25,740,000, or about £4 13s. per cent. on the invested capital. The market value of the property, according to Mr. Martin, who appears to have made a very liberal estimate, is £607,000,000. Now, according to the best authorities, we could not purchase this property for less than one thousand millions sterling. Mr. Allport says it could not be purchased even for that sum; and several other gentlemen, of equally good authority, agree with him in that opinion, or in other words, that the shareholders would not be satisfied with the payment of four hundred millions sterling in lieu of "consequential profits," so we may dismiss at once the idea of purchase on such terms; and it must be remembered we are not in a position to enforce any terms inconsistent with the act of 1844.

We can well remember the sudden rise that took place, a few years since, in telegraph shares when it became known that

Government intended to recommend to parliament the purchase of the telegraph lines. They suddenly sprang up to such a price that it became a question whether or not the project of purchase should be altogether abandoned. If the market price is a test of value, the telegraph lines were bought at the rate of fifty to one hundred per cent. beyond what they were worth; but, under the particular circumstances of the case, perhaps to close the bargain was the wisest thing that Government could do. Even with the exorbitant prices that were paid, the investment, under Government management, has turned out most profitable and advantageous to the nation. How much better, however, would it have been if the property could have been obtained at a fair price?

We can well imagine, after our experience about the telegraph share market, the effect that would be produced upon the Stock Exchange by an authentic announcement that Government intended to recommend to parliament the purchase by the state of all the railways in the United Kingdom. Taking the price paid for the telegraphs alone, their market value, as a fair standard to regulate the price that should be paid for railways, a bonus of four hundred millions would certainly be required. Although Mr. Allport and his friends assert, in effect, that the railways could not be purchased for a thousand millions, that sum, it must be remembered, is very large, and I cannot help thinking that the Government, with proper management, might obtain them on those terms. The payment for "consequential profits" would be in that case no greater than the claim from our American cousins for "consequential damages," and not more unreasonable, and exactly double the sum agreed upon and now nearly paid by France to Germany for the war indemnity.

It is assumed, however, throughout the whole of the discussions that have taken place in reference to this subject, that the nation must either submit to any demands, however exorbitant they may be, to obtain possession of the railways, or be obliged to allow the present system to remain as it is. Now, that is the special matter to which I wish to direct your attention. The railways of this country may one day be purchased by the state, but if ever that day should come, it will be when the position of parties is changed, when the directors of the companies must come to the Government, and not when Government would be obliged to go to the directors. The companies are now masters of the position, and until more advanced opinions are held throughout the country, the ownership of railways must remain in the same hands.

In the examination of witnesses before the committee of 1844, one of them was asked by a member the following question: "It would be perfectly possible, would it not, that the Government itself might undertake to make a competing line in such a way as to effect a reduction of charges upon the public, both upon the old line and the new one?" The answer was: "Certainly; there would be nothing to prevent it." The next question was: "Assuming that to be the case, and assuming that would be the proper remedy for excessive rates and charges, do you think that would be the best plan that could be adopted under the circumstances?" The reply was: "I would much rather see a competing line in the hands of the Government than in the hands of a private company." It no doubt occasionally happens that some member of a committee may ask questions not very pertinent to the matter under consideration, and the witness who answers them may be totally unqualified to give a proper answer, but these objections do not apply to the present case. The member who asked these questions was Mr. Gladstone, chairman of the committee, and the witness who answered was Mr. Glyn, for many years chairman of the London and North-Western Railway.

Now, whatever mistake the legislature may have made in their dealings with the companies, they have been always clear and distinct in maintaining their right to permit the construction of competing lines, and they have of course the same power to permit such lines being constructed by Government. Mr. Glyn made a very judicious answer in saying he preferred that an opposition line should be in the hands of the Government in preference to those of a private company, because in the former case they would have a moral right to ask the legislature to take the railway off their hands at its market price, and in the latter case they might be ruined without any compensation whatever.

It is generally known that a universal feeling prevails throughout Ireland that her railways should be purchased by the state, amalgamated under one system of management, and that a low and uniform tariff should be established throughout the country. The capital invested in the Irish railways is £27,000,000 and pays at present about 4¼ per cent.; on the English railways it is about a half per cent. more. Government has, however, lately expressed a decided opinion against the policy of, under any circumstances, becoming a trader, and therefore declines to be in any way a party to the purchase of the Irish railways. But it would be hard to say whether the feeling in Ireland in favour of the purchase of the railways by the state, or the extension of the railway system, is the stronger of the two. No one can question the right of the legislature to authorize Government to construct railways, and the assertion of these rights, in a modified form, is particularly applicable to the state of Ireland. Ireland does not want competing lines. There are 2,000 miles of railway completed, and it would take about 1,200 more to complete the Irish railway system. These lines cannot be constructed under a commercial system, because there is no present probability of their paying 5 per cent.; but the counties through which they would pass would only be too happy to be supplied with railways and give a guarantee on the county rates that Government interest would be paid; in that case we would establish in Ireland a mixed system, as in Belgium and Germany, by which the public mind in England would be directed to the subject in a much more demonstrative form than is the case at present.

The English people possess the abstract right to construct their own railways, and when that right is practically asserted, the claim of £400,000,000 for consequential profits will disappear. But to obtain this end the proper means must be used. In 1839, Lord Melbourne, then Prime Minister, declared that "the man must be mad who declared the corn laws could be repealed." Yet within seven years from the time of that declaration being made the corn laws had ceased to exist. But how did that come to pass? The merchants and traders of Manchester, who felt themselves specially aggrieved by the operation of the corn laws, organized a great league, and promulgated their grievances and the grievances of the public through the length and breadth of the land, and so the tax upon bread fell. The merchants and traders of Liverpool have their special grievances to complain of, in regard to the tax specially imposed on their trade and commerce, and if they adopt the same means to abolish that imposition, the like success may be expected to attend their efforts. We may look with confidence to other quarters for support.

The late Mr. W. Bridges Adams, an engineer of great eminence, directed the attention of the London and North-Western board, some years since, to the great desirability of constructing a line for passenger traffic only between London and Liverpool. He stated that there was a constantly increasing number of people to whom time is exceedingly valuable, and to whom expense is comparatively no object, and who wish to travel at the highest rate of speed that can be attained. A speed of fifty or sixty miles an hour, he said, could be attained with perfect safety and with no excessive cost, if only a clear and well-conducted line and well-constructed trains were used. In short, the lines must be passenger lines, and not goods lines. Goods, he said, did not pay well, except in heavy trains drawn by heavy engines, and at comparatively slow speeds; and if passengers are to travel on goods lines, they should travel at the same rates of speed, in order to insure safety. Duplicating the main lines will not get over the difficulty, by keeping the fast trains to one pair of lines, and the slow to the other pair. Goods need warehouses, and sidings, and crossings, and a great number of porters; and, whether the passenger lines be side lines or central, the goods lines will interfere with the traffic. Passenger trains actually travel at speeds from fifty to sixty miles an hour on rails in inferior condition. This rate involves considerable risk from bad points and from collisions with goods trains; the great majority of accidents on railways occur through such collisions, which cannot be absolutely provided against. If light engines and light trains be used with corresponding rails in thorough order, and with no impeding traffic, these rates of speed might be maintained without any risk, and without any immediate evil. But it would not do to permit any heavy, destructive goods traffic on such lines. If light goods were permitted during the night, the engines and waggons should be equally well constructed with the passenger trains, with no greater load per wheel and with less speed.

"But would it pay the London and North-Western Company," asks Mr. Adams, "to have distinct passenger lines of great speed?"

That, he says, must depend upon the wealth or commercial importance of the district. If the expenditure in law were light, and the land could be rented at its agricultural value on a lease of 999 years, lines of double railway might be constructed for fast light trains, at the rate of £10,000 to £15,000 per mile, including locomotives and rolling stock of the best quality. The convenience of humanity would be studied at the same time in the construction of the carriages; they would be lofty enough to permit standing upright; they would be ten feet in width, with a central passage-way, to permit the guard to pass from one end of the train to the other, thus getting rid of the great difficulty of

want of communication between guard and driver. On either side the passage would be enclosed cabins or apartments for four persons each, for passengers wishing to be private; and open saloons would be provided for the gregariously disposed. The seats of the passengers would be arranged to fold up against the partition, so that each passenger might sit or stand at pleasare. Arrangements would be made to provide tea, coffee, and similar refreshments whilst travelling, and also for efficient warming, ventilating, and lighting; and by fitting construction, easy movement, without vibration or oscillation, would enable the traveller to read or write at pleasure. In this mode a constant speed of from 50 to 60 miles per hour could be maintained, without the necessity of the traveller alighting or injuring his nerves by vibration of the train, or his digestive organs by swallowing food in too great a hurry, or at too distant intervals of time.

Such was Mr. Adams' scheme for constructing a passenger line between London and Liverpool; and when such a line is constructed by Government—if ever such an event takes place—it will be time enough to settle the terms on which the state shall purchase the railways.

The passenger fares that Government would adopt would naturally require the greatest consideration, but they should be no more tentative than the adoption of the penny post was tentative. Low fares should be at once adopted. Every class and every section of the community would equally benefit from a large reduction of fares—to be uniform throughout the country. The fares I suggested to the royal commission that should be adopted by Government were, for first and second-class, by express trains, 1½*d.*, and 1*d.* per mile; by ordinary trains, first, second, and third, 1¼*d.*, ¾*d.*, and ½*d.*; by slow goods, or excursion trains, ¾*d.*, ½*d.*, ¼*d.* The Irish Railway Commissioners recommended that uniform fares of 1¼*d.*, ¾*d.*, and ½*d.* should be adopted throughout the country.

The working of the system of Government purchase would be very simple, if the principle was recognized and the practice carried out of Government constructing such lines as the legislature approved of; if there were individuals or districts particularly interested in the construction of any railway not in itself objectionable, let them be called on to give security to the Treasury against loss, as frequently is done now in Ireland to companies, by security on county rates or otherwise.

As regards the companies, the value of their property could not be depreciated, for they should have a right to call on Government to purchase their lines—if they found their profits decreasing—at its fair market value, previous to that decrease in traffic having commenced. So that even if the value of their line was reduced by Government competition, the shareholders would still receive the full value, and the money market would not be in the least disturbed.

I suggested to the committee of 1844 that it would be desirable by an arrangement with some of the companies which had no competing lines, to carry passengers at very low fares, and thus ascertain the extent to which passenger traffic could be increased. If such an experiment, for instance, by an arrangement with the companies, could be tried on the underground lines of the metropolis, the result would throw great light on the subject.

To many of our legislators, in their individual capacity, we are indebted in no small degree for those great reforms, constitutional and commercial, that in the course of the last forty years have brought about such a wonderful change in the state of this country. It would be impossible to refer to any great measure of reform without identifying it with one or more members of our legislature, to whose unwearied exertions—it may be for many years—we are indebted for the creation and formation of that public opinion through which those measures became ultimately the law of the land. To overcome the *vis inertiæ* of mankind has been in all ages and countries a matter of the greatest difficulty; and it is only when the attempt to do so proceeds from an influential quarter that there is much likelihood of its being successful. Every word spoken by a man of eminence, either in parliament or elsewhere, on public occasions, is noted down and circulated through the length and breadth of the land. All newspapers, without distinction of party, give currency to his opinions, expressed in his own words; those opinions are made the subject of comment, favourable or otherwise, as the case may be, and thus commences the growth and formation of what we call public opinion. So, in regard to a reform of our railway system, it is scarcely arrived at the first stage of existence; but one day it may become a living principle. Now it is a mere idea, but in the course of time that idea may be developed into a great plan, recognized by the nation, adopted by the legislature, and working for the benefit of the whole community through all classes of society.

Discussion.

Mr. C. B. Vignoles, F.R.S., said for the last forty years he had been intimately acquainted with the railway system in the United Kingdom, and had long considered this question and the steps taken by the legislature. In England the feeling was so strong that everything possible should be left to private enterprise, that public opinion revolted against the idea of Government interfering, except in special cases. The argument had always been that the great communications of the country should be in the hands of the Government, and, in looking to the future, he thought it possible, and even probable, that the railways might eventually come into the possession of the state. But that could only be done by the force of public opinion. There were many arguments and facts bearing on this question which had not been discussed in the paper, but nevertheless it would be valuable as a matter of history. Allusion has been made to the Irish railways. Some forty years ago the Government were anxious to develope the resources of that country, and, in order that the railways might be carried in a proper direction, a railway commission was established; the conclusions that they came to were that the average of railways in that country, good and bad, would not pay more than 4½ per cent., and they recommended certain lines which would yield that return. The Government published the report and circulated it, but it did not meet with much general acceptance, and the project of railways being made by the state was abandoned, the whole matter being left to private enterprise. Private enterprise immediately seized upon all the profitable lines, especially the one to the south of Ireland, on which, after some twenty years, about five per cent. dividend was now paid. The other lines proved as nearly as possible, in proportion to their length and traffic, exactly what the commission had predicted. In consequence, the great body of Irish railway proprietors, when they found their hopes disappointed, came knocking at the door of Government, and asking that the railways should be purchased; but the Government very properly declined to accede to their request. In his opinion the state should not take over the railways until the railways came and offered themselves, though, no doubt, if public opinion insisted upon their being purchased, as the telegraph system had been, no doubt it would be right to do so. With respect to foreign railways, the general practice had been to retain them in the hands of the state, or, at all events, to give Government the control; and the last advantage the state had reserved to themselves was the right of purchase. In France, it was endeavoured, first of all, to get railways made entirely by the state; failing that, they endeavoured to get them made by companies; and failing that also, the Government offered to construct the works and let them to the companies, on condition of their laying down the permanent way and providing rolling stock. The German system was too complicated to be stated at such a meeting, but they all retained the ultimate right to purchase upon terms fixed beforehand. The English legislature thought it would be more encouraging to capitalists to give them the right, or monopoly, as it turned out, in their own hands; and now the question arose, whether it was or was not politic to purchase the railways. The result of his experience and reflection was that this time was not yet come, and that Government should wait until the companies came and asked to be purchased.

Mr. F. J. Bramwell, C.E., said that the reader of the paper had commenced by stating that he must make a most overwhelming case before the Government could be called upon to purchase the railways. But so far from doing so, he appeared to have made an extraordinarily feeble one. With regard to the passenger traffic, in order to get to any source of complaint, he had had to go as far back as 1842, and even then the complaint was simply that third-class passengers were ten hours going to Bristol, and were not in enclosed carriages. But it was only twelve years previously that the first working passenger railway had been commenced, and that stage coaches and waggons were still in existence. Was not, then, the condition of third-class passengers, who got to Bristol in ten hours, and at least with a roof over them, better than that of gentlemen who rode outside a stage-coach, without any roof at all, and did not do the journey in ten hours? Two years afterwards parliament protected the third-class passengers by regulating the speed and the fares at which they should be carried. Then, with regard to goods, the only instance brought forward was the complaint of Liverpool, an important town, no doubt; but still it only appeared to be that some other towns were better used. He presumed that the railways were only acting within their parliamentary power, and charging within the limit. Admitting that this might be a real source of complaint, and remarking that Mr. Galt had not at all shown that the public were better

served on the Continent, with regard either to goods or passenger traffic, he wished to point to one or two matters which made it appear to him absolutely disastrous to contemplate railways being in the hands of the state. If this were accomplished, the state would be expected to make a great reduction in passenger fares and in the rates of goods, and to make these fares as uniform as possible. It was also suggested that the railways should do no more than cover their working expenses, and pay a moderate interest on the outlay. Now, if there were no other mode of communication throughout the kingdom it might be practicable, but was the government to become the possessors also of all the coasting trade and of all the canals? If not, what would be the effect? These trades would be in the hands of private individuals—certainly the coasting trade, who would have to compete with the Government monopoly, under which, of course, they could not survive. Then there was the difficulty as to making new lines. It was said long ago there ought to be trunk lines, and branch lines connected with them. But the system would never answer practically. When the first line was made from Birmingham to Warrington, connections were made from Warrington to Liverpool on the one side, and to Manchester on the other, but it was many years after that before even the private companies found it to their advantage, under pressure, to make the diagonal lines from Crewe to Manchester on the one side, and they had since made one to Liverpool on the other. Now, if things were in the hands of the Government, it would be impossible, he feared, to get anything in the way of extra accommodation, and when it was got, it would be very often given for political purposes. All these were matters he had not intended to touch upon when he came into the room. But there was one other point more within his own sphere—viz., influence on mechanical engineering. He believed that to put the railways into the hands of the Government would be one of the greatest misfortunes for the advance of mechanical engineering and the future of railway locomotion which could possibly be. At the head of the department there would probably be an engineer officer, who would have under him some men who really understood the subject, but who had not been very prosperous. Amongst them they would devise a typical locomotive, and that being fixed, it would never be changed. No one would dare to do so, and this in itself would be a great bar to improvement. Then another thing would happen. Occasionally even Government locomotives would explode; there would be a great outcry, and he presumed Government would not pay for those who were killed, as the railway companies now did. The result would be, it would be said, "We must be more saving, we must take off the pressure." Then there would be sometimes collisions, and it would be said, "We must be more careful, we must have lower speed." In this way it would be endeavoured to cure these matters. But this would not be in the interest of the public, for he did consider it was for the interest of the public that a few persons per annum should be killed, rather than that the whole nation should be forced to travel slowly.

Mr. F. C. COTTERILL said the subject naturally divided itself into two parts. First, that of general amalgamation; and, secondly, whether it should be undertaken by the Government. With regard to the first point, in 1849 public opinion was most decidedly in favour of competition. At that time he was in communication with some of the leading statesmen of the day, who all agreed that amalgamation was most desirable, but that it would be ridiculous to propose it at that time. Since then the principle of competition had been applied most perniciously by the state; in fact he did not believe history recorded anything so serious as the pernicious consequences which followed from that doctrine. He agreed cordially in the general principle of the great advantage of amalgamation, but he differed from the reader of the paper with respect to the state purchasing the railway property. He believed any such proposal would make all Chancellors of the Exchequer rise in mutiny at the idea of anything so preposterous. But, at the same time, he believed it was the duty of the Government to originate new lines, and to control and supervise the whole system of railways. If there were a central board appointed, to carry out, in the first instance, a general amalgamation of all the railways, equitably apportioning the stock amongst the existing owners, and in the next place controlling the management, and originating new undertakings when required, he thought that would meet all the requirements of the case.

Mr. ELLIOTT remarked that he took rather a special view of the matter, and one which he feared would not be altogether in accord with the mode in which these matters were generally discussed. Much had been said about the financial part of the question, but that he thought was of very small importance, for it only amounted to this, that capitalists would advance the money to the Government instead of to boards of directors. No doubt they would get 5 per cent. from the Government, which would very well satisfy them. But the advantage which would accrue to the public was quite another thing. What evidence was there that any advantage would accrue? They had heard a great deal about Belgium, but nobody had yet said that the management of railways there was better than in this country, and those who had had long experience there told him it was not so, and, more than that, the system was used for political purposes. It was said that travelling was cheaper on the Continent, but it was not right to talk about the tariff in Belgium and France unless their whole scale of salaries and expenditure were reduced in the same proportion. The Postmaster-General in Belgium, who was also manager of the railways, received £600 a-year, and other officials in the like proportion, and he apprehended Englishmen would not submit to that sort of thing. Let them keep up their own profits and wages, and keep up the prices of the railways, and not bring anything down to the low level of foreign habits and manners. The subordinates on English railways were paid quite little enough already, and there would soon be an outcry if any attempt was made to reduce them. But if the Government were to take railways into their own hands, why, on every principle of reasoning, ought not the steamboat traffic, or even the making of bread, to be undertaken by the state? But all these considerations, serious as they were, were but as a feather in the balance compared with the most important part, namely, Government power and patronage. He saw nothing in what was called the progress of public opinion to lead any thinking man to suppose that there was a higher sense of morality and greater accountability to the principle of utility in all this. He saw the contrary, and he believed that placing such enormous power in the hands of the Government would be another of those fatal steps which were now being taken in the course of national decline. The jobbery, instability, and forgetfulness of the public interest shown in railway management at the present time, bad as it sometimes was, would be nothing compared to the incapacity and dishonesty which would be developed by Government management. They heard about quicker transit, greater safety, and so on, but was the human mind a different thing when the man had a Government uniform on than when he had a railway uniform on? Were those who selected these men more to be trusted when they were Government officials than when they were railway directors? He thought not, nor was there any evidence to the contrary. It was even said some years ago that the Crimean war would have been conducted by a joint-stock company with much less sacrifice of life and money, and he believed there was a great deal of truth in the statement. Would the Peninsular and Oriental Company have sent the "Megæra" to sea in the state she was, or would any trading company have constructed and sent out such a vessel as the "Captain" to the Bay of Biscay? Then, look at the immense power such a matter would put into the hands of the Government. There was an example now going on in Canada, where there was a railway being constructed by the Government, which would not be finished for sixteen years, and a gentleman who had lived there many years, quite free from all political bias, told him that that was a test case, and the power which they had, in consequence of the construction of the railway and their command of the labour market, was most formidable. Again, having at their command an army of some 300,000 men, in addition to the present standing army and navy, would be, in his opinion, most dangerous to the public liberty. On the whole, therefore, he strongly deprecated any such step as was advocated by Mr. Galt.

Mr. E. LAWRENCE observed that there was another matter, but which had not been touched upon by the last speaker, which was very important to be borne in mind. Only a few days ago, in the leading journal, a strong contrast was drawn between the state in society in France and this country, and it was contended that France owed its present position largely to the fact that the education and talent of the country looked to the Government for place and position rather than to private enterprise; whereas, in this country, the same parties, so far from looking to Government employment, in many cases despised it. He thought it would be anything but an advantage for the number of Government *employés* to be so largely increased. There was one other point to be borne in mind, namely, that so long as the country went on prosperously, and the railways made a profit, things would go on smoothly; but times would come when the country would not be so prosperous as at present. In those times ministers would have difficulty in raising taxation, and the trade of the country would also fall off, and the railroads, instead of being a source of profit, would show, perhaps, ten millions deficit. In what position would a Chancellor of the Exchequer then be in, having to raise that large amount of taxation to pay the interest owing for the railroads?

Mr. EDWIN CHADWICK, C. B., having moved the adjournment of the discussion,

The CHAIRMAN said he would not be able to be present at the adjourned meeting, and he would, therefore, briefly state his views upon the important question before the meeting, though he came prepared to listen rather than to lay down any propositions of his own. He had not the slightest doubt that if the public really wanted the railways purchased by the state it could be done; the question of price would not present any insuperable obstacle. It would be a very serious question, and no doubt, as in the case of the telegraphs, it would be very advantageous to the sellers, but not so much so to the purchasers. He did not, however, lay very much stress upon that difficulty, nor would he say how far state management was better or worse than that of individuals or companies. A very curious change had taken place in public opinion with regard to that subject within the last fifteen or sixteen years. At the time of the Crimean war anybody would have been hooted down who ventured to propose that anything which was in the hands of private individuals or public companies should be taken over by the state. There was at the time a tendency greatly to exaggerate the weakness of state management, and to magnify the advantages of private management. Now the tide had turned, and there was a danger of running to the opposite extreme. What were the difficulties which would really have to be faced before any such gigantic change as that which had been proposed could be made? In the first place, was it wise, without the strongest necessity, to make the state responsible for six or eight hundred millions of debt more than at present? If anybody were to say that the time might come when the railways would be superseded, it would, no doubt, be a bold assertion; but it was very difficult to fix a limit to the inventive powers of mankind; and the present form and manner of railway communication could hardly be adopted as altogether final. There might be great differences of gauge, and possibly a general adoption of locomotive power on common roads. Changes which could not now be foreseen might exceedingly diminish the value of the capital now invested in railways. What would have happened if the state, yielding to arguments of the kind now brought forward, had bought up all the canal property, and had undertaken all the coaching business of the country? There would have been an enormous loss incurred, and not only so, but the state would have been under the strongest possible inducement to check and prevent any alteration in the existing mode of communication. No doubt if a change took place now which to any extent superseded the present railway system, it would be a very serious misfortune to a large class of the community; still it would be a misfortune which would fall only on individuals. Then, as has been said by Mr. Lawrence, it was all very well for the state to go into these speculative enterprises as long as a continuous upward movement could be reckoned on; but if at any time, he would not say of national decline, but of national difficulties—railway receipts were to fall off, the national receipts would also be falling off; and the responsibilities which the state was now asked to take upon itself in a time of prosperity would tend to diminish its resources just at the moment when that loss would be most seriously felt. But, apart from that question of loss, was it wise to have so large a portion of the public revenue as would be required devoted to paying off interest on debt? National debts all over Europe and the civilised world were growing; every ten years there was an increase of the indebtedness of the great governments of the world. He was apprehensive that in other countries—he did not say it would be so here—this would produce an awkward result. Questions might arise not very easy to deal with in an abstract and speculative way about the right of the legislature to tax posterity, and possibly all over Europe schemes of partial repudiation might be discussed, and it would be held out to the people suffering under the pressure of taxation, that they might relieve themselves by reducing the interest on the debt. He was not seriously afraid of such a feeling arising here, partly because Englishmen in many things had more sense than their neighbours, and partly because the burden was comparatively little felt; but if questions of that kind were being raised it would not be any advantage, in discussing them, to have to deal, not with a debt, excluding terminable annuities, of about 700 millions, but of 1,200, 1,300, or 1,400 millions. The relations between the state and labour must also be considered. The number of persons employed under the state, supposing the state to take over the railways, would undoubtedly be several hundred thousands, and consequently the state would be by far the largest employer of labour in the country. Now, questions of capital and labour had never been more keenly discussed than during the last few years; but hitherto the state had always kept itself absolutely impartial as between employer and employed. Was it, then, a prudent thing, at a time when these questions are more likely to be raised than before, that the state should abandon that position of neutrality, and itself become a deeply interested party on the side of the employer? Railway servants, constituting an exceedingly powerful body, would probably demand higher pay and shorter hours. If those demands were resisted, the state would be exposed to great unpopularity, while, on the other hand, if they were complied with, a large hole would be made in the profits to be derived from the railways. The really serious part of the question, however, was this—how would it be possible for the state to avoid exercising enormous local patronage which would affect every district and town throughout the country. He did not refer to the minor question of the appointment of railway servants, though there would be a great deal of small patronage in that way, and he did not believe that it would be possible to dispose of it under the theory of competitive examination, in case of employments which required little but mechanical and manual labour. That was a very small part of the question of patronage; what he feared was the position of dependence into which every town would be brought towards the railway board or administrative body with which the decision would rest as to what new lines, stations, or extension of railway communications should be made. Every town in the country might ask at the same moment for extended railway communication, and it was quite clear the request of all could not be complied with at the same time. It would be necessary that a choice should be made, and that choice might be governed by political preferences—at any rate, whether it was so or not, you would never get it out of the heads of the people that it was so. This was a control, not over individuals, but over the constituency as a whole, which no extension of the franchise and no manner of taking the votes would affect in the slightest degree. In France every public work, every road, every bridge, every public building, had been constructed by or with the assistance of the state, and whether truly or falsely, it was continually said in the days of Louis Philippe, and had been continually said from that time to this, that those who returned members in favour of the Government got their works executed, and those who did not got nothing. That was corruption wholesale, and he feared it could not be avoided. It would be very difficult to constitute the railway board in such a way that it would not be dependent on the minister of the day. An administration controlling a property of 600 or 700 millions, and employing several hundred thousand persons, would make itself felt in every corner of the country; if detached from the executive it would be an *imperium in imperio*, and if attached to it, it would not be easy to detach it from political party. There was an important question touched upon by Mr. Bramwell, as to its being the interest of the state to discourage the making of new lines. Of course, if the same returns could be obtained without giving increased accommodation, it would be to the advantage of the railway board not to make these new lines. At present, imperfect as the system might be, there was, to some extent, a remedy for that danger. If a company absolutely refused to provide the accommodation required, some other company would grasp at the chance, and whether it carried its bill or not, at any rate the wants of the district made themselves felt, and a good deal of accommodation was given in that way, which, without fear of competition, would never be given at all. If the whole thing were in the hands of one central management, there would be an end of that, and the public in general, expecting to profit by the railway system, would be directly interested in not giving that accommodation to any particular district, unless it were clearly made out beforehand that the line would give a good return. The same argument applied to all questions of machinery and engineering improvements, as to which there would be a strong tendency to settle down into one type, from which it would be very difficult to induce those who managed the matter to deviate. The question of canals or steamboats, and of docks, was also a serious one. It would never do to have the railways worked by a central board, while the canals, which competed with the railways, were in private hands, and he always assumed that if the state had to buy the railways it must buy the canals also. Then, again, where there was competition between steam-boats and railways, the owner of a steamboat would complain grievously of being brought into competition with the state; and there would be a strong pressure to take these steamboat companies also. The same rule would apply to docks, for whoever had the control of the railway system had an enormous power of carrying traffic to docks in one place and of diverting it from docks in another. It would very soon be said that if the whole internal communications of the country were in the hands of the state, it would not do for docks to be left in private or local hands. He would not go into what had been said about the experience of foreign countries, but with regard to passenger traffic he did not think they need envy their foreign neighbours. The general conclusion at which he arrived was, that although the objections he had mentioned might be capable of receiving an answer, up to the present time they had not received an answer, and therefore he thought it—"Better to

bear the ills we have than fly to others that we know not of." If the process of amalgamation continued, and the whole railway system got into the hands of six or seven great companies, it would alter the question so far, and necessitate a greater amount of supervision by the state than had hitherto been desirable, because in that case all semblance of competition would cease. At present, however, he did not think such a case had been made out, either against the actual system, clumsy and imperfect as it might be, or in favour of that proposed to be substituted for it, as would justify the nation in embarking upon such an important undertaking as the doubling of the national debt, and placing the whole railway system in the hands of the state. In conclusion, he begged to thank Mr. Galt for the very able and suggestive paper which he had read, and to observe that sound argument was never lost, whether on one side or the other. You sometimes did not know how strong your own case was until you heard the other party's case fairly and strongly put.

The discussion was then adjourned until the following Wednesday evening, the 18th inst., at eight o'clock. On that evening the chair was taken by the Marquis of CLANRICARDE, and the discussion was resumed by—

Mr. EDWIN CHADWICK, C. B., who spoke as follows :—The noble lord who did us the honour to preside at our last meeting concluded his summing up of the discussion of that day by declaring that, in his opinion, it was "better to bear the ills we have than fly to others that we know not of." Now, those who have paid special attention to the subject will, I think, agree that, by his lordship, the ills we have were not duly recognized and estimated, whilst the ills that we know not of, by any experience from any change of the kind required, will on impartial examination be found to be exaggerated or illusory. I will endeavour to enumerate the chief evils we have. In the first place, the chief trunk lines of communication, which ought, for economy and efficiency, to be under unity of system, are under one hundred and ten independent bodies, administering them separately, entirely for a trading profit, instead of mainly for the cost of the service, which is a large organic economic distinction. By this disunity the transit of goods from one end of the kingdom to the other is obstructed, often by varying rates, which are fixed without reference to any common principle, and are only to be known upon inquiries, which cost valuable time. By this disunity, combined with the severance of the trading bodies from the public service, the use of twelve thousand postal establishments, as receiving and delivering houses for larger parcels than letter parcels (as in Germany and Switzerland), is lost, and a large trade prevented. By this disunity the transit of passengers is obstructed, especially in cross traffic, to their constant annoyance, and frequently to the loss of time to the extent of one-third. By this disunity, attended by differences of signals and practice, additional dangers to life and limb, and insecurity and discomfort in travelling, are occasioned. By this disunity, combined with unnecessary competing duplicate and even triplicate lines, often running from the same places at the same times, necessitating additional rolling stock and establishments, —the working expenses are augmented, it is declared, upwards of 20 or to 25 per cent. By this disunity, combined with the condition in which the public means of transit is conducted by private traders, as for a trading profit, the expenses of construction are largely augmented, and also the price of capital, to the extent of the difference between the price of public and private securities. By the conditions of the railways as concerns for trading profit, needed extensions of the branch lines, to an extent nearly of the main lines, are prevented. As a general result, there is an augmented cost of transit of passengers, generally of one-third beyond those which obtain on the governmental lines, under unity of management, and also on goods the excess of cost of transit is of the like proportions, especially of the transit of small bulks. These increased charges to the public, arising from false economical and administrative principles, are attended by reduced dividends to shareholders, who having been generally inveigled to advance their capital on the promises of 10 per cent. —promises implied in provisions that they should be restrained to 10 per cent.—have been subjected to cruel losses, and would have generally benefited if they had kept their money in their pockets. Added to these evils are those of inferior organization, affecting injuriously the condition of the rank and file of an army of nearly three hundred thousand persons engaged in the railway service. Now it has here been contended, at least by me, from the first, that the gains derivable from unity would constitute a capital divisible between the public and the shareholders (and it was implied the service also), affording the shareholders some improvement in their dividends, and, above all, that great gain would be derivable in the rateable value of their property arising from the substitution of a public security for the private security of traders, which would cost the public nothing for their dividends and their bond debts. On the working expenses alone, by evidence beyond dispute, the saving from unity would be upwards of six millions. Added to this is an indisputable saving of 1¼ per cent. on all the bond debts. On the last time I propounded this conclusion in this hall, the railway directorates and managers treated the then existing disunity as a final fact, and their own management as the best possible. But what have they been doing since then but making advances towards unity, only for an entire profit for themselves, which we say ought to be divided with the public? All that they have been stating to the shareholders of the advantages of sectional amalgamations is confirmatory at every point of what we have stated of the advantages of a general amalgamation, and serves as an answer to what they have before said. They are now, for their own exclusive profit, for reducing disunity, from a hundred and ten down to four. I have not been in a position to examine the recent proposals for amalgamation, but, from what I have observed of previous amalgamations, they were very badly done, and with inferior results. I have paid very special attention to administrative consolidations, as it was a duty to do, and I conceive that from results obtained I have a right to an opinion upon them. At one time the seventeen thousand separate parochial administrations were asserted to be ultimate conditions, and my proposals for consolidation were treated as wild impracticabilities. An advance was made in consolidation to six hundred unions, which, though very imperfectly done, was attended with an early annual saving of four millions of expenditure; and subsequent experience is demonstrative of the expediency of further advances in the principles originally proposed. Now I venture to assert that the work of complete railway amalgamation is really a far less difficult administrative task than that, and even if it were roughly set about, it may be accomplished in far shorter time. In vindication of this opinion I must beg to refer to what was said of it in this room by the class of opponents to telegraphic postal reform, who were people with the like interests and like ideas to the opponents of railway reform, the case for which in principle is essentially the same. A statement prepared by the Hon. Robert Grimston, the chairman of the International Telegraph Company—was sent to the members of parliament, in which it was asserted, in respect to the trading telegraph system :—"It is worthy of observation that ours is the only European country in which the telegraphs are not a monopoly in the hands of the Government ; and it is also worthy of observation that, under a system of free competition, we have made more progress and have arrived at a higher standard of excellence in telegraphy than any country in the world." The half-franc messages of Belgium and Switzerland, and the equivalent of sixpenny messages in Germany, were set aside as of no account as against asserted inferiority in mechanical execution ; just as now on the railway question the half and one-third less continental rates are held to be of no account, as against the higher speeds obtained on some lines in England, the fact being that people on the Continent dislike those high speeds. To avoid the inconvenience of rebutting such objections, by comparisons of foreign systems, which occupy time, I will call attention to our own case as respects disunity. Addressing the directors, I say :—"Do you mean to assert that the saving of six millions for working expenses, and the other savings alleged to be derivable from unity are of no account? And if you do, why do you now make so much account of the lesser saving from amalgamation, that is to say, from sectional unity ; and why do you incur such heavy expense in conflicts for it, and how is it that your shares rise at a remote prospect of it?" The telegraph companies' case asserted that, "in opposition to all precedent on the subject, it is now for the first time set up by Mr. Ward Hunt, as the exponent of the principle of monopoly (under the guidance of Mr. Edwin Chadwick), that a telegraphic monopoly would be advantageous to the public. He (Mr. Hunt) believed that if they had a monopoly of the telegraph they would easily lower the tariff, and at the same time make the undertaking yield a profit." The answer to these dogmatic declarations in behalf of such competition is, that under the principle of unity the price, including the reduction of porterage, has been reduced nearly one half, and the messages, now progressively increasing, have been increased from 236,326,000, the number at the period at which the telegraphs were first taken over, to 300,843,000 for the corresponding period of the last year. "For its own part, and for the other companies, the Electric and International Telegraph Companies deny that many important districts are without any such means of communication. They challenge the Government to prove that issue." The issue is proved by the event that, as against the 2,932 stations belonging to the competing companies, who, like the present railways, were not in a position to make any considerable further number of extensions, as they could not make them with a trading profit,—the total number of stations now open is 5,790, and in every part of the country

more are being called for. The dogmatism with which we are now met by the persons engaged in the interests of the railway companies is the same as that with which we were met by the telegraph companies. "Messrs. Scudamore and Chadwick based their whole argument before the Society of Arts upon the facilities which the post-offices would afford for the working of the electric telegraphs in small towns and country districts. Their notion was that the village postmaster or postmistress would act as the telegraphist; that the village postman, or, as Mr. Edwin Chadwick suggested, the national or the British school children, could act as the distributors, and that there would be an ample return for the first course of construction and the annual cost of maintenance in the telegraphic correspondence of the country." "In the first place, the persons employed, as a rule, are quite unfit to be employed as telegraphists. Telegraph clerks require regular training before they can become efficient manipulators; and it is found that they must commence young, and that to keep a machine in working order requires on the part of the telegraphist some knowledge of electricity and mechanism, such as village postmasters and postmistresses cannot be expected to acquire; it follows, that in every respect they would be very unsuitable persons for the proposed duties to be devolved upon them." The answer is, that we do see village schoolboys, neatly dressed, acting as good messengers, and that 2,600 postmasters and postmistresses are employed in telegraph work, and as only one complaint is received for every 1,379 messages, the presumption is that they do the work in a satisfactory manner. I have appended answers obtained from the Post Office on other points, and especially on the point insisted upon by Mr. Bramwell, that Government, as against the existing trading management, must check the progress of improvements in the arts. However, it is right to state that the telegraph companies did me far too much honour in ascribing to me the initiation of that measure. The fact is, it had been initiated in the department years before it was taken up here, and at a time when the companies' interests, for which the public have had to pay seven millions, might have been bought for two. The cost of the long official inattention to the subject, the direct cost of false economical doctrines, such as have been advanced on this railway question, was at the least half a million a year from the time the subject was taken up here. The present cost to the public of that delay is shilling messages instead of sixpenny messages, which would bring the telegraph within the reach of small traders and the working classes; and of more than a quarter of a million of surplus revenue. The present cost of the like inattention is, as respects the ocean telegraphs, upwards of half a million a year to the public, and to the mercantile community charges extensively prohibitory, as we have shown, four shillings a word, instead of one shilling a word messages. The cost of the delay from interested and false economical and administrative doctrine in respect to the railways is indisputably some ten millions a-year of excessive expenditure, derivable from unity, by the shareholders and the service; and to every traveller an excess of fare of a third, at the least, of the fare he pays for every journey, and also an excess of risks of life and limb, from proved mismanagement in the great majority of cases. To every manufacturer or merchant the cost of delay is an excess of rates of at least one-third on all the goods he sends. If I am asked on what ground I assert that these reduced railway fares would be equally productive, I answer on the same grounds on which we asserted that, if fair play were given to them, the third-class passenger rates of a penny a mile would be the most productive, which the railway directors declared would be their ruin, but are now proving to be their best fortune; and on the same grounds that the reduced telegraph rates, which the directors declared would produce a loss, are now producing an increased profit. The fact is that there is a great amount of interest-begotten prejudice and opinion that has been allowed to pass current as impartial public opinion on this question. I remember an early student's instruction from Locke on the Conduct of the Understanding, that might be well remembered on this subject. He said, "When you come to examine any question with a view to any conclusion, the first thing you ought to do is to consider the state of your interest on the question, and take it into account." I remember when I went to give evidence before the railway commission, I could not but say to myself, Who is that commissioner who interrupts my exposition with a determined cross-examination on an irrelevant issue? Why, he is the chairman of a railway company. Who is he who manifests a supreme contempt for the economical doctrine of competition for the field as against competition within the field, and the inapplicability of competition to the case in question? Why, he is the chairman of a company for an enterprise which, in a field fully occupied by one capital, and not receiving a high dividend, desires a second to divide it and be bought up. Who is that commissioner who displays such apathy and listlessness to the doctrines interfering with private enterprise? Why, he is the head of a great banking house having immense railway accounts, which would be swept away by a public system. And so with noble lords whose rent-rolls have been largely increased by the private enterprise, very much at the expense of the shareholders. Delicacy of feeling should have prevented them occupying such positions. Wishing to put the best construction on such an arrangement, it may be surmised that the commission may have been so packed in order to see how much concession might be got from representative men of the hundred and twenty-four railway directors in the House of Commons, and the fifty-eight railway directors in the House of Lords—a formidable body of one hundred and seventy-two members for a prime minister to think of dealing with, unsupported by public opinion, for disestablishment. The electric telegraph directors were particularly shocked, as the railway directors are, at additional patronage getting into the hands of the Government; "Why, it would equal the patronage of the Inland Revenue, or of any other department except that of the Customs itself!" It were better, in their views, for the public to bear the ills they had (of dear and restricted communication) than to fly to others of which the directors knew, though the public knew not. So the railway directorates in parliament are clearly of opinion that the patronage of the force of three hundred thousand men is best in their keeping. The men themselves, however, I venture to say, from inquiries I have made of them on occasions, in different parts of the country, will be glad to change masters, and as shown by open manifestations at Derby and elsewhere, will now cast their ballots in the direction of the interests of the public as well as themselves, for a change of system. On this point, as to the patronage, I would particularly appeal to Lord Derby, who has set a most distinguished example in the promotion of open competition for first appointments for the public service, which, despite of all the opposition of patronage hunters, is acting very well. Does he not think the principle may be applied, in this case, by improved methods, to obviate the dangers he apprehends? Again, he presided at a meeting, at the United Service Institution, to promote civil appointments to deserving soldiers, an object in which I concurred. Would not railways afford useful aid in that direction? Beyond that, would not a drill, given to a large proportion of the men, as an occasional relief, and as a holiday—and, indeed, would not a good drill, as a qualification for first appointments to the ranks, serve as a valuable addition to our defensive force, and as a means of important military economy? Good military authorities are decidedly of opinion that it would. But the railway protectionists assume that the change of system can only be made according to their own notions. "Government" means, with them, the distracted attention of a changing political chief, commonly destitute of special aptitudes, and leaving office before he can acquire them, after presiding over a sham board like the Board of Trade. They assume their own price, and that the whole money is to be raised by loan, and that all the *personnel* is to be changed, and that the modes of appointment are to remain much the same. But is contract management to have no place? Is not the working of the contract system, which, besides postal packet service, yet includes three-sevenths of the postal conveyance by land, notoriously better than the railway contract system? At last a principle of contract service has been introduced into the postal service, under which a district postmaster agrees to do the work of a district for a given sum, he providing such subordinate service as he thinks fit, and being responsible. Sir Rowland Hill, as well as his brother, Mr. Frederic Hill, has fully considered the objections to the important points of state management as to the employment of labour, and has disposed of them. If that principle had been applied when it was proposed, probably a quarter of a million of saving would have accrued to the public in that department alone. And why should not that principle, the principle of contract service, and payment by results, be extensively applied under unity in railway administration? Lord Derby apprehends that there may be public inconvenience in making additions to the national debt. Why, the railway reforms proposed are eminently calculated to yield profit, to augment prosperity, and strength to bear that burden, and eventually to reduce it. Some ten millions of annual relief from working expenses and high interest and fifteen millions of reduced transit rates would constitute an amount of saving greater than the charge of the debt itself. Mr. Hammond Chubb, the secretary to the Bank of England, has dissipated the thick fogs raised by the railway financiers, whose financing shareholders have such good ground to deplore and distrust. He has shown that not loss, but gain, is derivable from the transfer of the income of the disunited companies to the state. He says that "up to the end of the last year the purchase of telegraphs had cost £6,678,000. The interest on this sum at 3½ per cent. amounted to £217,000 per annum. But the income of the tele-

graph companies, which they divided in profits, was over £350,000. Therefore, for £217,000 a year the Government had purchased an income of £350,000." Just so; and, be it borne in mind, we have urged the acquisition of more profit to the public by the purchase of the ocean lines and the completion of the system. Mr. Chubb observes, "that the principle on which to calculate the purchase of the railways was not what was the gross sum necessary to buy them, but would it involve a greater sum in the shape of interest to the state than the companies were now distributing as dividends?" May we not contemplate a proportionate surplus to the revenue, a million or so, from a properly-conducted transaction on the same principle, and is that, together with all the other demonstrated gains, to be foregone from year to year for an imagined contingent—financial contingent—inconvenience, which the gains are powerfully calculated to prevent? His lordship has a forecast, beyond what men of science have, that we may some time hence get cheaper means of transit than by railways. Are we for this promised cheapness to another generation to sustain all the present dearness of disunity to the present generation, for the sake of nursing a future loss to shareholders; and will not unity and immediate cheapness be the best to meet any change? His lordship forebodes future manufacturing distresses and disturbances of the labour markets, and discontents. Why, the measures proposed for freeing and cheapening intercommunication, and thence promoting arts, manufactures, and commerce, are just the measures calculated to avert them, and when they arise to relieve them. One great means of relieving congested labour markets and of steadying them is cheapness of transit. He cannot have been informed of the grievous obstructions, created by high railway charges, to the relief of the working classes during the cotton famine by the removal of themselves and their families to places of demand. On the whole, the chief evils pictured, as the evils "we know not of," when examined, will turn out to be mere illusions; and when they are to any extent possibilities they will be best met by conditions of augmented strength, by greater cheapness and freedom of transit, and better internal as well as external communication. I am glad that Dr. Farr, after a study of the subject, concurs with us that the question of free railways is of infinitely greater importance than the old question of freedom of trade in its narrow sense. That related to the burden of a million or two of import duties on corn. This system is of many millions of railway directorates, export as well as import duties, on all commodities—on persons as well as on things. It would be for the shareholders as well as the manufacturers to consider whether a railway reform league is not more needed than the old corn law reform league, to inform and advance public opinion against sinister interests, misrepresentation, and opposition.

Mr. BOTLY remarked that a discussion on the same subject had taken place in 1865. In reference to that debate, he wished to call public attention to two letters which had appeared in the "Journal" of the society on the 7th of February, 1866, and the 18th of May in the same year, written by Mr. Sydney Smith. The reading of those letters and other circulars which had come to his attention, as well as the powerful arguments of Mr. Chadwick on the present occasion, had thoroughly altered his opinion on the matter, and he was now quite convinced that it would be a judicious thing for the railways to be acquired by the state. It must be remembered also that the purchase and control of railways were two different things, and, though the last few paragraphs in Mr. Galt's paper appeared to be lost sight of, they were really very important. He referred to the suggestion that it was quite open to the public authorities to make any railways for themselves, if the present proprietors of railway stock did not come to reasonable terms; and he believed that two or three trunk lines laid out in this way would be of great service to the country, and in fact, to all parties.

Colonel STRANGE, F. R. S., said he was encouraged to say a few words on this subject from having taken part in somewhat similar proceedings, leading to the enunciation of what he would venture to term the same fallacies as beset the discussion of the present question, namely, the aid of Government in the advancement of physical science. This matter was one which nobody expected would be settled soon; it would have to be discussed, and a great deal of nonsense talked before the true bearings of the question were discovered. To get a clear view of the subject it was necessary to sweep away some preliminary obstacles, one being that it was inexpedient that the Government should interfere with private enterprise. Whenever the sentiment was expressed by one who felt it in his own breast—which he (Colonel Strange) did not—it was always well received. It had lately been uttered by Mr. Gladstone and Mr. Lowe, in the presence of those best able to see the hollowness of the sentiment, men of science, and yet it was well received. There seemed to be something very attractive about it, though he could not see what it was. Those who used the expression seemed to forget what they were arguing against—they were simply arguing against civilization. That word, like all others, was open to a great many definitions, but the one he proposed to give was this:—Civilization was that which interfered with individual enterprise and individual liberty—for there could be no civilization unless individual liberty and enterprise were interfered with. He said that boldly. The principle of barbarism was to let every man do as he pleased—to scalp his enemy, and to eat him—but civilization stepped in and said, "You shall not scalp your enemy and eat him; your enemy shall be killed, but you must not kill him. We will kill him for you, and you shall be deprived of part of your property to pay for the trouble we take in the matter." Let them ask themselves where would they be if Government did not interfere with private enterprise in such matters as the post-office, the police, the army and navy, and so on. Was civilization to stop at a certain point, or had anybody yet indicated the point at which it was to stop? No; it must progress, and he felt certain there would yet be a further augmentation of central authority, and a further diminution of the freedom of individuals in certain matters. Then it became a question what those matters should be. This preliminary objection, that they were not to do this, that, or the other thing, because it was an interference with private enterprise, thus appeared quite untenable. Another prejudice, as he would venture to call it, was that if the state took possession of the railways it would be equal to a doubling of the national debt. He contended it would not be a debt at all, but simply an investment, the details of which could be arranged and settled very easily. The railways were held by the moneyed classes of England, and if they were transferred to the state the capital would still be held by the same persons; in fact the transaction would simply amount to this, that a certain set of gentlemen were going to sell themselves their own property, and it would be very strange if they made a loss by it. The third fallacy was that Government management was not as good as private management. He did not think the meeting would endorse that sentiment; no one supposed they would have abler men than at present to conduct the railways, but they would have intellect concentrated and applied to a system of unity instead of being scattered and diffused throughout the country—the agency would be more concentrated. Another fallacy was that if the railways were in the hands of the Government there would not be the same tendency to improvement as at present. Having had something to do with railway matters and contracts, and having been a little behind the scenes, he did not think there was any such intense desire for improvement as they had been told existed. He had spoken to one of the most eminent engineers on the subject, who agreed with him, to this extent at any rate, that there was no tendency to improve in the direction of economy of construction. It certainly was not the tendency for engineers to cut down the first cost of their works. They repudiated the idea of fixed salaries, their idea being a commission on the cost, and consequently it was not to their interest to introduce such contrivances as should make railways, canals, and docks cheaper. The larger and more expensive the undertaking the more commission they received. He did not say this with the slightest idea of any imputation upon their integrity; but there could be no doubt that they were powerfully interested in making the cost of engineering works as large as they conscientiously could. That kind of thing would not exist to the same extent if matters were in the hands of the Government, because the engineer would receive a fixed salary. Mr. Galt was charged with having stated that the case required to be made an overwhelming one before the purchase could be adopted, and that he had not done so. He agreed that Mr. Galt had said so, but he did not attempt to make out that case. He only put before the meeting various considerations why the state should purchase the railways, and there left it. He thought, however, that Mr. Galt was mistaken in saying that the Government must not go to the companies to purchase the railways, but that the railways must come to the Government. He thought the time would come when, the public having got excited about this question, some politician would see his way to making a political cry of "Buy the railways!" and that it would be done in that way, and not by any other means. That was how most great measures had been manipulated of late years, and that would probably be the case with this. Public opinion itself would not suffice until some man saw his way to use it, so as to increase his own position and to satisfy his own ambition.

Mr. FREDERICK HILL said the speech of Lord Derby at the previous meeting caused much matter for comment, but the noble lord himself had stated that perhaps his objections were capable of being answered, and he believed two of them at least were completely answered in the "Times" of the following morning. Mr. Chadwick had also replied to some of the objections raised very ably, and so had Col. Strange, and he now

wished to lay before the meeting a few considerations of a somewhat different character from those which had as yet occupied their attention. No doubt Government interference, as it was termed, was a great bugbear to many people, and it might seem rather difficult to know where to draw the line. Everybody admitted that Government only could act in some matters, such as protection to life and property and so on, and on the other hand it could not be disputed that there were many things which it would be very unwise for Government to interfere with. He believed the true line of demarcation was this, that Government might advantageously undertake the management of anything which upon sufficient trial should prove in its hands more productive than it would if left to private enterprise. If Government required a monopoly, he, although a Government servant, should say unhesitatingly, "Do not give it;" but if with a fair field and no favour Government could beat private enterprise, in such a case they were justified in taking the matter up. This rule was well exemplified in the case of the telegraphs, and, though a monopoly was there secured to the state, he contended that it was not at all necessary—nor did he believe it was even in the case of the Post Office—and as the bill was originally proposed no monopoly was suggested. There was no necessity in the case of the railways for going headlong into the matter; let it have a fair trial on a moderate scale, and if the country were found to be benefited, and no injury done to railway proprietors, it could easily be extended. On the other hand, if the management by the Government was less successful, let it be given up. It was now nearly twenty years since he had first taken up this question. He attempted to show, as was now very generally admitted, after millions of money had been wasted, that in railways, as in anything else, where the number of competitors was necessarily small, competition was merely a delusion. Sooner or later in such cases—and generally sooner rather than later—there would be a union of interests, and even the semblance of competition would vanish. He had also asserted from the beginning that railway amalgamation would be beneficial to the public interests, and ought not to be discouraged, and he contended that the experience of the lines in the north-eastern part of the country fully bore out this argument, having been beneficial both to the shareholders and to the public. Now, every partial amalgamation was a step to complete amalgamation, and the latter would only be completed by the state possessing the railways. It had been very generally assumed that state possession meant state management, but this was by no means the case, and it was an error to suppose that either he or his brother Sir Rowland had ever advocated the latter. His own claim to speak with authority on this question was small, but considering the clear manner in which his brother had put forward his views upon the matter, and considering his position as the originator and successful administrator of one of the greatest financial experiments of the age—the penny post—he really thought the facts and arguments he had adduced with regard to the railways deserved more consideration than they had received. What he proposed was this, not that Government should undertake the management, but that, following the principle glanced at by Mr. Chadwick, of contract management, the railways which had become the property of the state should be divided into convenient groups and put up to public competition, in the following form. Government having undertaken to pay a certain fixed sum per annum to the former proprietors, the basis of the contract must be that that sum should be paid by the contractor, the Government thus simply having the duty of receiving the money with one hand and paying it with the other; and the competition would be simply who, on that basis, would undertake to work the railways at the lowest tariff, and generally on the most advantageous terms for the public, of course giving proper security for keeping up the plant in good order, providing against accidents and so on. In this way, for the first time in the history of railways, would competition really be brought into play, and that in its most healthy form. It would be open to the whole world, and those who had an aptitude for administration and powers of organization would, by and bye, make it their profession, and either at the head of companies, or otherwise, would undertake these concerns and work them in a way which no body of amateurs could ever hope to imitate. If this plan were adopted, all the fears which had been expressed about political influence, financial jobbing, patronage, &c., would fall to the ground; and there would also be this great advantage, that Government would not be exposed to constant applications and pressure of all kinds to lower the rates beyond the point at which they ought to stand in order to make the railway self-supporting. The contractors would stand between the Government and the public, and nobody would think of asking a contractor, any more than a baker, to sell his goods at half-price. All the official staff required would be a small body of thoroughly competent men to see that the covenants of the lease were properly fulfilled. As to the price to be paid for the railways, a great deal of misconception seemed to prevail. Mr. Martin, in his paper read at the Statistical Society, estimated the present market value of the railways at about 600 millions; but then he added some immense sum for what was called prospective advantages, which he contended was a mere illusion. All future contingencies, whether advantageous or the reverse, were included in the calculations made by clever men on the Stock Exchange who settled the market price of the day. No one who wanted to turn railway shares into cash would think of instructing his broker to add 50 or 100 per cent. to the market price for "prospective advantages," or if he did he would never get rid of them. He, like many others, held railway stock; for instance, he had some shares in the Caledonian Railway which were now quoted at 96¼. If anybody would add ten per cent. to that he should be very glad to part with the whole of his shares, and he apprehended any other holder would also. Proceeding in that way, the 600 millions sterling would not be raised to 1,200 millions, as it had been by Mr. Allport, but to only 660 millions. There was no necessity at all for the Government to deal with this business wholesale. His brother and he had suggested that they should begin with the Irish railways, which were a compact body separate from the rest, of a moderate value, and which were suffering much more than English lines from divided management. Or any particular group of either English or Scotch lines might be taken in the same way. About 30 millions would buy the Irish railways, and even if the experiment failed, and they had to be sold again, the loss, in such a case, could not be put at more than a fourth, or say £8,000,000, which was not a very alarming sum to such a nation as England. If the matter were looked at calmly in that way, seeing with how much safety the experiment could be tried, he did not think there would be so many objections. With regard to the economy of working by contract, he might mention that that was first applied to the steamboat conveyance of mails between Bombay and Aden, on behalf of the then Indian Government: the result was that whereas the conveyance had cost the East Indian Company £120,000 a year, the Peninsular and Oriental Steam Ship Company sent in a tender, which was accepted and carried out with perfect satisfaction, to perform the same service for £20,000! That was an extreme case, no doubt, but it showed unmistakeably the tendency of competition. Mr. Chadwick was not quite correct in what he had stated in reference to the contract system lately introduced in the Post Office, though he thought it might with advantage be as that gentleman had represented. What was done, in addition to the large application of the contract system to the conveyance of mails by omnibuses, mounted messengers, &c., was to take a certain class of work in one department—that of money orders—which it was found cost a certain sum of money, and invite the clerks to say what they would do it for, finding their own assistants. The practical result had been that whereas the meritorious clerks who became the successful competitors had their income nearly doubled, the expenses of the department had been considerably reduced, the work being at the same time at least as well performed as before. Some persons preferred Government management for the railways altogether, and if that view were pressed he should say take two groups of railways and give each system a trial, and although a Government servant himself, he had not the slightest expectation that the Government management would equal that of the contractor, either in economy or efficiency. In conclusion he would only say, that both himself and brother were strongly of opinion that under the contract system, such as he had sketched out, not only would better returns be given to the shareholders, but a lower tariff and greater security obtained by the public.

Mr. EDWIN CHADWICK, in explanation, said he so far appreciated Sir Rowland Hill's views on this matter that he made a distinct effort to get them brought forward at the Statistical Society. The error into which he had fallen with regard to the contract system in the Post Office arose from having read the last report rather hurriedly.

Mr. BASS, M.P., said he was largely concerned with railway traffic, having during the last eleven months paid £14,000 for railway carriage. From various reports of committees he learnt that the charges for conveying goods in Belgium and other countries were considerably less than in England, and considered it would be much to his advantage if the state were to purchase the railways, and only make such charges as would return a reasonable profit. It had been proved, before committee, that the cost for conveying goods in Belgium was from 80 to 90 per cent. lower than in this country, and he was persuaded that if the state were to take possession of the railways in any manner consistent with equity, they would be in a condition still further to reduce those charges; and, considering how large a proportion of the cost of production was caused by the rates for carriage, it was easy to see that the general trade and prosperity

of the country would be greatly enhanced by any condition of things which would insure a large reduction of railway charges. Lord Derby seemed to think that they incurred the danger of some invention being brought out which would dispense with railways, such as conveying the goods in the air; but that was a probability which they ought not to take into consideration. But supposing that, some thirty or forty years hence, the railways would not be so valuable as now, in consequence of some new invention, if the railways remained in the hands of the present proprietors they would suffer the loss, and it did not make much difference whether they lost the money or the state. It was very dogmatically stated that the possession of the railways by the state was impossible to consequence of the proposed change of Government, because they would become the largest employers of labour in the country. He disputed that altogether. There was no necessity for the Government or ministry to take the management—an independent department might be constituted for the purpose; and, as to the working classes being affected, he considered they would be more benefited than anybody. Besides, the conduct of railway *employés* would compare favourably with that of any other body of men, and he did not at all fear their acting unreasonably if employed by the state. It had been stated by Mr. Bidder, before a committee in 1865 or 1866, that third-class passengers might be conveyed at a farthing a mile, and other authorities confirmed that view, and that a very material reduction might be made with great advantage. The number of third-class passengers were, compared with first and second-class, as five to two, and the revenue derived from third-class passengers was not very far short from that obtained from both the first and second put together; and with regard to the cost of conducting the passengers, five third-class passengers could be conveyed for the same price as one first-class; therefore his conviction was that a public department might safely reduce the cost of third-class passengers one-half. By so doing they would make a larger profit than at present, because it would be impossible to calculate the enormous increase there would be in the number of travellers which that reduction would produce.

Mr. HALE expressed his opinion strongly in favour of the state purchasing the railways, the importance of the measure being shown by the fact that the capital invested in these enterprises had doubled itself within a very recent period. He attributed a great deal of the success of railways under private management, and the comparative immunity from accident, to the control of Government through the Board of Trade, and considered that all the arguments which had been adduced against the measure might be easily met; indeed, he did not believe those who put them forward now would hold to them themselves ten years hence.

Colonel GORE then moved the further adjournment of the discussion to Thursday evening, the 26th inst., at eight o'clock, which was agreed to unanimously, and which will be reported in our next number.

Chemistry applied to the Arts, Metallurgy, Chemical Manufactures, and Allied Subjects.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF CHEMICAL SOCIETIES, &c.

§ 1. *Acids, Alkalies, and Salts.*

SYNTHESIS of Ammonia.—W. F. DONKIN finds that by treating a mixture of dry hydrogen and nitrogen with induced electricity, a small amount of ammonia is produced. The author's observations appear to have been made in ignorance of the contemporaneous researches of M. Thénard. ("Practical Magazine," June, p. 435.) *Proceedings of the Royal Society, xxi.* 281.

Alkaloids.—HLASIWETZ states, in a preliminary notice, that he has succeeded in obtaining definite crystallizable oxidation products from cinchonine, from the study of which it is hoped that some light may be thrown on the constitution of the quinine alkaloids and analogous substances, a necessary preliminary to any attempt to procure these substances by artificial means. *Annalen d. Chem. u. Pharm. clxvii.* 88.

C. R. A. WRIGHT has obtained some new derivatives from codeine, allied in character to several of the derivatives formerly obtained. In physiological action these differ in many respects from the parent base. *Chemical News, xxvii.* 287.

BOEKE states, in a preliminary notice, that he has obtained substances free from nitrogen by heating quinine together with zinc-sodium and excess of zinc dust. *Berichte der Deut. Chem. Ges. vi.* 488.

MERCK finds that hyoscyamine is a volatile *liquid* base, and not a crystalline substance as previously described by other chemists. It forms salts readily, neutralizing acids completely. The nitrate and oxalate are crystalline, the sulphate and hydrochloride amorphous. *N. Report. Pharm. xxii.* 117.

PHIPSON states that anthracenamine is obtainable by reducing nitroanthracene by tin and hydrochloric acid. It is a yellow powder, and forms a crystalline sulphate and hydrochloride. Its acid salts yield a characteristic emerald green colour, with potassium dichromate or nitric acid. Bleaching powder, however, does not produce this tint, nor does peroxide of lead. *Chem. News, xxvii.* 97.

Nitrate of Ammonia.—F. M. RAOULT states that when dry ammoniacal gas is passed over crystallized ammonia nitrate, the gas is absorbed, and a liquid produced consisting of the salt dissolved in liquefied ammonia. By exposure to the air, crystals are formed containing one equivalent of gas to one of the salt. These crystals are very unstable, constantly giving off ammonia till the ordinary nitrate alone is left. *Comptes Rendus, May* 19, 1873.

[*Note by Abstractor.*—E. Divers observed most of the above facts and published them some months ago. *Vide Proceedings of the Royal Society, xxi.* 109, *and Prac. Mag. p.* 273.—C. R. A. WRIGHT.]

Manufacture of Magnesium Compounds.—FREYDIER-DUBREUL patents the treatment of calcined dolomite suspended in water with sulphurous acid (from the burning of sulphur or the roasting of pyrites). The bisulphites of lime and magnesia thus formed are calcined in such a way as to become converted into sulphates of magnesium and calcium, separable by water. By heating the sulphates with carbon, sulphides are formed. These can also be produced by treating dolomite with sulphuretted hydrogen, whereby, under certain conditions, magnesium is dissolved out first. Again, magnesia may be separated by employing dolomite for the clarification of syrups, whereby sucrate of lime is formed and dissolved, the magnesia being untouched. *Bull. Soc. Chim. Paris, xix.* 478.

[*Note by Abstractor.*—The process for extracting magnesia from dolomite by means of carbonic acid, whereby a soluble bicarbonate of magnesium is formed before the lime is attacked, has been in use for many years. It appears to be a much more simple process than any of the above.—C. R. A. WRIGHT.]

Bleaching Liquor.—H. DEACON patents the use of carbonate of lime of various kinds instead of caustic lime for the manufacture of bleaching liquor. The carbonate, more or less impregnated with soda or potash, obtained by causticizing soda or potash with quicklime, and containing more or less caustic lime, may be employed with ordinary apparatus, carbonic acid being evolved; or chalk or limestone may be used in a tower up which pure or diluted chlorine passes and down which water trickles. This process is more especially adapted for the utilization of chlorine diluted with carbonic acid, &c. By addition of acids to the resulting liquor, undiluted chlorine may be obtained. *Chemical News, xxvii.* 296.

Salts of Glucinum.—ATTERBERG describes two hydrates, the ordinary sulphate, which is not isomorphous with either iron or copper sulphate; a basic sulphate; double sulphates of glucinum and potassium, glucinum and sodium, and glucinum and ammonium; the seleniate; the sulphite; the selenite; the hyposulphite; the chromate; the molybdate; the chlorate; the iodate; and the double mercury and glucinum chloride. *Bulletin de la Soc. Chim. Paris, xix.* 497.

Lead Salts and other Compounds.—MARRIOTT patents an improved apparatus for reducing lead to powder. The powdered lead is mixed up with water by an agitator, streams of air and carbonic acid being blown in; thereby carbonate of lead is formed, which is washed away by water and collected apart. *Chemical News, xxvii.* 296.

Preparation and Properties of Monochloride of Gold.—G. LEUCHS directs attention to differences in the processes given in various chemical text-books for the preparation of this body, and to the unsatisfactory results obtained by some of them. The author's experiments show that when trichloride of gold is heated the evolution of chlorine does not stop when the trichloride has been reduced to the monochloride, but often goes on till the compound is entirely reduced to metallic gold. This result is, according to the investigator, due

GEMS OF INDUSTRIAL ART.

WALNUT-WOOD DINING-ROOM PIECE, IN THE GREEK STYLE.

By M. P. Mazaroz-Ribalier.

to the action of moisture in the air, which, being absorbed by the hygroscopic trichloride, decomposes the monochloride into metal and trichloride, the latter again taking up water, and so on.

To prevent this, the author proceeds thus :—The trichloride is heated in a basin on a sand-bath to 200°-300° C., and is constantly triturated with a pestle. The liquefied red chloride turns first brownish-red, then dirty brown, yellowish-brown and dry ; after more heating, greenish, and finally clear yellow. As soon as the mass becomes of a greenish colour, the temperature is lowered gradually to 180°. The evolution of chlorine does not cease even here, and the end of the operation is to be recognized only by the changes of colour. When the powder has become pure yellow coloured, it is taken to a cool place, triturated as long as it smells still of chlorine, and finally put into a glass vessel. This monochloride appears of a pure yellowish-white. *Dingler's Polyt. Journ. ccvi.* 463.

§ 2.—*Metallurgy.*

Cast Steel from the Bessemer Process.—NOBLET gives the following analyses made by Kezler :—

—	Crude Mixture.		Finished Metal.	
	A.	B.	A.	B.
Graphite . . .	2·410	2·52	0·020	0·000
Carbon . . .	0·620	1·06	0·190	0·450
Silica	2·410	1·87	0·160	0·083
Phosphorus . .	0·130	0·10	0·150	0·104
Sulphur . . .	0·024	0·37	0·021	0·080
Manganese . .	2·450	1·04	0·220	0·340

Samples taken at various stages during the process were also examined, with the general result of showing that no elimination whatever of phosphorus takes place during the process. Thus :—

	Per cent. of Phosphorus.
Original material	0·100
After four minutes	0·106
Beginning of second period . .	0·096
Middle of „ . .	0·097
Before spiegel introduced . . .	0·109
Finished metal.	0·104

Revue Universelle des Mines, &c. Jan. and Feb. 1873.

Gases contained in Iron and Steel.—TROOST and HAUTEFEUILLE find that iron when fused in an atmosphere of hydrogen takes up a quantity of that gas, which is disengaged again with "spitting" on suddenly diminishing the pressure ; if similarly treated in contact with carbonic oxide, the same result is obtained, less gas, however, being taken up. Thus 500 grammes of pig-iron gave these results :—

Total gas.	In hydrogen. 46·6 ccs.	In carbonic oxide. 16·9 ccs.
Carbonic oxide . .	2·36	86·98
Hydrogen . . .	94·42	8·87
Nitrogen	3·22	4·15
	100·00	100·00

When steel is similarly treated analogous results are obtained, as also with malleable iron.

Total gas.	In hydrogen.		In carbonic oxide.	
	Steel. 7·8 ccs.	Malleable iron. 13·9 ccs.	Steel. 3·2 ccs.	Malleable iron. 14 ccs.
Carbonic oxide	11·53	4·31	62·50	97·85
Hydrogen .	82·05	71·94	25·00	1·43
Nitrogen . .	6·42	13·75	12·50	0·72
	100·00	100·00	100·00	100·00

When steel, pig iron, and malleable iron fresh from the forge or furnace are examined, the following gases are found to be present in 500 grammes of metal.

Total gas.	Steel. 2·20 ccs.	Pig iron. 16·7 ccs.	Malleable iron. 18·5 ccs.
Carbonic acid .	2·27	3·59	11·89
Carbonic oxide .	63·65	16·76	58·38
Hydrogen . .	22·72	74·07	23·78
Nitrogen . .	11·36	5·58	5·95
	100·00	100·00	100·00

Comptes Rendus, lxxvi. 562.

Danks' Furnace.—V. TAHON sums up his opinion thus : Danks' apparatus is perfectly practical, and is capable of being employed regularly for lengthened periods ; the mechanical motion effects the purification of the iron in a much better way than the old puddling process, increasing the yield and quality, and diminishing the number of hands required. *Revue Universelle des Mines, &c., Jan.*, 1873.

Meteoric Iron from Cape Colony.—L. SMITH found that a meteorite which originally weighed 3¼ kilogrammes, had the density 7·692, and contained

Iron . . .	88·83 per cent.
Nickel . .	10·14 „
Cobalt . .	0·53 „
Copper . .	trace „
Phosphorus .	0·28 „
	99·78

The interior had a brilliant metallic appearance, the outside being oxidized. Schreibersite is disseminated through the mass, and a kidney-shaped mass of pyrites 0·038 metre long, and 0·025 broad, enveloped in a coating of schreibersite, about 0·001 metre thick, was also found. *Comptes Rendus, lxxv.* 294.

Prevention of Corrosion of Iron.—SMITH patents the use of alloys of a slightly more electro-positive character than iron to protect that metal from corrosion. Bands of an alloy of zinc and tin are applied to the metal at equidistant intervals, the surface of the alloy being 1 or 2 to 144 of iron to be protected. In accordance with the usual galvanic rules, the more electro-positive alloy is corroded in preference to the iron. *Bulletin de la Soc. Chem. Paris, xix.* 528.

On the causes of the Rusting of Iron.—Experiments made by VON HUTTEN have led to the following statements :—

"The oxygen of the atmosphere, whether active or passive, effects oxidation of the iron only when the latter is in contact with water in which the oxygen is dissolved.

"In the same manner carbonic acid can induce the oxidation of iron only through the medium of water.

"The rusting of the iron does not cause the formation of ammonia, though this can take place simultaneously.

"The oxidation of iron is not lastingly prevented by alkaline solutions, but only so long as the oxygen has not penetrated through the solution to the metal, and this takes place far more slowly in such solutions than in water. The action of carbonic acid upon iron in alkaline solutions commences as soon as more carbonic acid is contained in the liquid than is necessary to neutralize the alkali." *Polyt. Centr.* 1872. 1346.

[*Note by Abstractor.*—The second part of the last observation appears to contradict the results obtained by Mr. CRACE CALVERT, who says that the carbonates and bicarbonates of alkalis act in the same manner as their hydrates in preventing the oxidation of iron. See "Practical Magazine," No. 1, p. 47.—R. G.]

Durability and Preservation of Iron Ships.—Sir W. FAIRBAIRN discusses the question as to the durability of iron ships when periodically and systematically inspected, and urges the importance of such inspections on the Admiralty and private shipowners. Machine riveting affords greater security that the rivets properly fill the holes, and can be done at the rate of 16 rivets per minute with a lever machine, 10 per minute with a steam riveting machine, and 0·66 rivet per minute by hand.

From a large number of experiments the author concludes—1. That joints with drilled holes are weaker, and elongate less before fracture than joints with drilled holes ; 2. That hand-riveted joints are somewhat stronger than machine-riveted joints ; and 3. That there is a decided increase in the strength of the rivet when the edges of the rivet holes are rounded so as to diminish their cutting action. Valuable practical information as to the quality of the plates can be obtained during the punching operations. Drilled holes, moreover, give weaker joints than punched rivet holes. *Proceedings of the Royal Society, xxi.* 259.

Zincing Iron.—The articles to be zinced are first steeped in sulphuric acid diluted with water so as to contain about 1 per cent. of acid. Dirt, &c., is then detached by rubbing with sand. The plates are then washed and kept in milk of lime till required for the next process, which consists of the treatment of the plates with zinc chloride solution (prepared by dissolving refuse zinc in hydrochloric acid and adding a little sal-ammoniac). The cleansed iron objects are introduced into this bath for a few

minutes, at the end of which time minute bubbles appear on the surface ; they are then dried on a hot plate and plunged into a bath of melted zinc, the surface of which has been cleansed from scum. *Dingler's Polytech. Journal, ccvii.* 340.

Coincidence of Spectral Lines of Iron, Calcium, and Titanium.—MATTIEU WILLIAMS suggests that these coincidences are not improbably due to the circumstance that it is extremely difficult to obtain iron free from calcium ; even specially purified finished iron contains ordinarily distinct traces of that metal, the author having never been able, in fact, to find any sample of iron or steel that did not contain it. Similarly, it is extremely probable that titanium is frequently present in iron, the tests for this element being difficult and unsatisfactory when only traces are present, and the examination for this substance being in consequence frequently omitted. *Nature, May 15th,* 1873, *p.* 46.

[*Note by Abstractor.*—The process by which the presence of traces of calcium were found in all the steel and iron examined is not described. It has occasionally happened that analysts have been misled through the unavoidable impurities in re-agents (especially acids) brought about by keeping in glass bottles, whereby portions of the constituents of the glass are gradually dissolved.—C. R. A. WRIGHT.]

Mines in Sardinia.—SELLA gives an elaborate report, from which it appears that galena (more or less argentiferous), blende (sulphide of zinc), pyrites, copper pyrites, and bodies derived from these by oxidation (*e.g.* calamine, sulphate of lead, &c.) are found, together with smaller quantities of sulphide of antimony, sulpharsenides and sulphantimonides of copper, cobalt, and nickel, grey copper, pyrargyrite, and other substances. *Revue Universelle des Mines, de la Metallurgie, des Travaux Publics, des Sciences et des Arts appliqués à l'Industrie. Nov. and Dec.* 1872.

Recovery of Tin from Tin Clippings.—This note contains additional observations by the inventor of the process, A. OTT, on his mode of working, which has been mentioned in a former number of this magazine (No. 2, p. 157). He now states that the hydrochloric acid used for dissolving the tin has to be heated to 65·5° C. (150° F.), and that the 2¾ per cent. of nitric acid are added, not in the beginning of the operation, but after a lapse of an hour and a-half. The precipitate of metallic tin must be pressed before being heated for melting, otherwise the loosely heaped crystalline powder would easily oxidize. He also proposes to substitute large glass cylinders for the copper drums. *Dingler's Polytech. Journal, ccvi.* 462.

Tinning the Inside of Lead Tubes.—A description of the mechanical processes for the manufacture of such tubes by Hamon's patent. The paper gives also tables of figures showing the comparative strength of pipes of lead, tin, and tinned lead. *Dingler's Polyt. Journ. cciii.* 432.

Platin-iridium.—The International Metric Commission have succeeded in obtaining bars of this alloy weighing 10 kilogs.; 9 kilogs. of platinum and 1 of iridium were fused by the oxy-hydrogen blowpipe in three-quarters of an hour, and were then cast in a mould made (like the melting furnace) of a single block of carbonate of lime, the interior walls of which became immediately causticized by the heat ; after cooling a bright ingot was obtained. This will be subjected to various mechanical processes, in order to give it precisely the required shape and dimensions necessary for the standards. *Les Mondes, xxxi.* 89.

Cleaning Silver Articles.—East Indian jewellers never touch silver ware with any abrasive substance, but use, instead of polishing paste, &c., slices of lemons ; the goods to be cleaned are well rubbed with these, and then left in a pan for a few hours, covered with slices. For delicate jewellery a large lime is cut in half, the article inserted, the two halves applied together and tied up for some hours ; the article is then washed in several waters, placed in a pan of nearly boiling soapsuds, stirred about, rinsed, and dried on a metal plate, the smooth parts being gently rubbed with wash-leather if required. Cyanide of potassium solution (rather weak) dissolves off the dirty surface gradually, but great care is required. Green tamarind pods (oxalate of potash) are greater detergents for gold and silver than lemons, and are often employed for the purpose of removing stains, fire-marks, &c. *Boston Journal of Chemistry.*

§ 3.—*Dyeing, Bleaching, Calico Printing, and allied Subjects.*

Dyeing Felt with Aniline Colours.—Aniline colours are very easily applicable to felt. There are two modes of imparting the desired colour to the goods : either the material itself is dyed before it is felted, or the dyeing is effected during the felting operation. In the latter case the dye solution must be applied at the beginning of the felting process, otherwise the felt would not be penetrated by the dye. *Dingler's Polyt. Journ. ccvi.* 421.

Red Colouring Matter from Aniline.—HAMEL finds that when aniline is treated with cold chloride of sulphur a red colouring matter is formed. This is soluble in acetic acid, alcohol, and ether, and on evaporation of the solution is left as a black, brilliant mass. A grey colouring matter is also contained in the oxide product, separable by addition of water to the solution of the crude mass. *Comptes Rendus, lxxvi.* 376.

Separation of Toluidine from Pseudo-Toluidine.—BINDSCHLEDER finds that these two bases may be practically separated by dissolving 10 kilogs. of commercial toluidine (heavy aniline, boiling at 198°—200°) in 25 litres of water, to which 2½ kilogs. of oxalic acid are added, and 6 litres of commercial hydrochloric acid at 20° Beaumé ; the whole is boiled and then cooled down to 60° and filtered rapidly through cloth : the crystalline mass deposited furnishes crystalline toluidine on distillation with caustic soda. The mother liquors, or filtrate, is treated with 2 kilogs. more of oxalic acid, whereby crystals containing much toluidine are thrown down ; on distillation with excess of caustic soda the completely cooled filtered liquor yields pseudo-toluidine sufficiently pure for commercial purposes. *Moniteur Quesneville,* 1873, 432.

Black Dye for Woollen and Semi-Woollen Goods.—The goods are boiled for an hour and a-half with

5 lbs. potassium chromate,
2 „ copper sulphate,
2 „ sulphuric acid.

After remaining all night they are boiled for an hour with

100 lbs. logwood,
10 „ fustic.
1 litre salammoniac solution.

The goods remain again all night, and are then washed with urine. *Polyt. Centralbl.* 1872, 1372.

Dyeing Silk.—E. DURWELL finds that purified silk fibre (fibroine) has a slight alkaline re-action, and that it is only capable of absorbing and fixing colouring matter in presence of an acid, such as sulphuric acid ; treatment of the dyed silk with an alkaline liquid causes the colour to be lost by the silk, it being washed out by the water present. This result is arrived at not only in the case of vegetable colouring matters, but even with coal-tar colours, which are, however, retained to a slight extent by the silk ; vegetable colour appears to be only imbibed to a very small extent. *Bull. Soc. Chim. Paris, xix.* 447.

Examination of the Colouring Matters in Textile Fabrics.—L. GABBA describes the results of qualitative tests applied to fabrics dyed with various blue colouring matters. Soda changes insoluble aniline blue to a brownish red, and decolorizes soluble blue ; it changes aniline to a violet tint, and Prussian blue to a yellowish hue. Hypochlorites bleach Saxony blue but not Prussian blue. Ultramarine is rendered colourless by acids, sulphuretted hydrogen being evolved. Molybdenum blue may be recognized by incinerating the fabric and testing the ashes for molybdenum and tin. *Gazzetta Chimica Italiana, ii.* 381.

Bleaching Animal Matters.—SAMAL and BEROUJOU patent the use of sulphide, polysulphide, or sulphhydrate of potassium and sodium for the purification of silk. These substances bleach wool at 50°. Aluminate of sodium or potassium may be also used, but in this case the silk becomes charged with alumina. *Bull. Soc. Chem. Paris, xix.* 478.

§ 4. *Food and Sanitary Matter.*

Aeration of Wine during Fermentation.—By forcing air into the must under a tolerably high pressure, the same results are obtained as by heating wine, viz., acceleration of the refining process and attainment in a few weeks of the properties possessed by wines fermented by the ordinary process and then kept for some years. This process, invented by M. d'Heureuse (San Francisco), has been adopted by American wine-growers and also cultivators in South Germany ; wines from California, thus treated, are freed from the earthy taste commonly possessed by wines from that district ; the process appears to be capable of application to the germination of malt, purification of water, vegetable oils, syrups, &c. &c. *Moniteur Quesneville,* 1873, 390.

Alcohol in Bread.—BOLAS states that ordinary bread as purchased in London (made by the aid of yeast) contains from 0·221 to 0·401 per cent. of its weight of alcohol not volatilized by the heat of the oven. Bread made by machine without yeast (aërated bread), on the other hand, contains no alcohol. Forty 2 lb. loaves are about equal in alcoholic strength to an ordinary bottle of port. *Chemical News, xxvii.* 271.

Manufacture of Starch Sugar (Glucose).—The process of converting starch into grape sugar by treatment with acids has attained considerable magnitude; in Alsace great attention is paid to this, transparent syrups free from all after taste being prepared there especially for the manufacture of liqueurs and for confectionary; also for the adulteration of honey and molasses, and for the manufacture of caramel. The addition of nitric acid to the sulphuric acid used to produce the transformation, causes the change to take place in less than half the time required when sulphuric acid alone is used. For 1 metric quintal of starch, 1 kilogram of sulphuric acid together with 130 grammes of nitric acid; the complete conversion of the starch is indicated by the cessation of the production of a violet tint with iodine solution; treatment with animal charcoal after neutralization with lime completes the operation. *Moniteur Quesneville*, 1873, 426.

New Disinfectant.—CUIGNET and DELANNE patent the use of a crystallizable substance to which they apply the term *phenic ether*: this is soluble in alcohol but not in water and has an agreeable odour; it is prepared by the dry distillation of benzoate of copper. *Bulletin de la Soc. Chim. Paris, xix.* 525.

Utilization of Sewage.—W. LEFELD (commissioned by the Prussian Minister of Agriculture), has carefully examined the various systems of dealing with sewage in this country: in several instances he finds that what are stated to be processes whereby a considerable profit is obtained, really lead to considerable pecuniary losses. In the case of the Edinburgh water meadows, cattle refuse to feed on grass which has been treated with sewage up to two days before cutting, the capillary tubes for some inches above the roots being filled with unassimilated fæcal matters. Where irrigation is adopted, the author considers that an acre of land should receive the excreta of from twenty to thirty-five persons. *Chemical News*, 1873, 240; *from a pamphlet entitled, "Der gegenwärtige Stand der Abfuhr- und Kanalisationsfrage in Grossbritannien. Berichte auf S. Excellenz, den kgl. Preuss. Minister für die Landwirthschaftlichen Angelegenheiten erstattet.*

Insecticide.—A preparation stated to be derived from the vegetable kingdom, and to be fatal to insects, but harmless to men and small animals, as cats, dogs, birds, &c., is sold under the name of *Insecticide foudroyant*, by E. Galzy of Lyon (Rhone). *Revue Hebdomadaire*, 1873, 256.

Boyle's Self-acting Airpump Ventilator.—Under this name a ventilating arrangement has been patented consisting of four sections, each acting independently of each other; the external air impinging on the lower plates or diaphragms is deflected at different angles over the central radial plates, and in passing out exhausts the internal chambers; foul air then rushes up the shaft connecting the ventilators with the place to be ventilated, thus producing a continuous upward current. These ventilators are said to be free from down-draught and are not liable to get out of order, not containing any moveable parts or intricate mechanical arrangement; they are constructed so as to harmonize with any required style of architecture.

According to the "North British Mail" of April 5th, 1873, trials have been made in Glasgow with these ventilators in the presence of several of the magistrates of that town, and many scientific men, with the result that from 550 to 600 cubic feet of air (on an average of several days) are extracted per minute by each ventilator, no perceptible current of air being thereby caused in the apartment thus ventilated. By means of a valve at bottom, the rate of ventilation can be regulated to any desired extent.

New Respirator.—Messrs. BARTON have patented a respirator for use by miners, firemen, and others who are forced to enter places filled with noxious vapours of any kind. This respirator consists of a metal case packed with cotton wool soaked in glycerine, and pieces of charcoal: it is fitted to a helmet which is worn by the firemen or miners. Other inventions for the same purpose have depended on an external supply of air, driven in through pipes as in a diving apparatus, but this requires no connection with any external apparatus, and has consequently a considerable advantage. It is stated that experiments made with it have proved entirely satisfactory. *Journal of the Society of Arts, May* 23, 1873.

Action of Peat Smoke on Vegetation.—PRESTEL concludes, from the examination of statistics of the rye-harvests and the days when peat-smoke was prevalent in Westphalia (between 1867 and 1871), that the harvest was *above* the average in those years when there was most smoke and below the average when there was least; this result negatives the ordinary opinion that the action of peat-smoke is prejudicial, at any rate to rye. *Ann. der Landwirthschaft*, 1872, 758.

Action of Metallic Compounds on Vegetation.—J. RAULIN finds that the *Aspergillus niger* flourishes much better when a minute quantity of zinc sulphate is present in the liquid with which the experimental soil is moistened, $\frac{1}{320000}$ of that salt increasing the yield three or four fold: on the other hand $\frac{1}{100000}$ of nitrate of silver, or $\frac{1}{3000000}$ of corrosive sublimate prevents development. The presence or absence of iron salts appears to produce little effect. *Ann. der Landwirthschaft*, 1873, 93.

Methods of Embalming.—JEANNEL describes the various methods that have been in use for this purpose, viz., *dessication*, which occasionally takes place by natural processes; *freezing* and *preservation at low temperatures*, which cannot be practically used for any lengthened period. *Impregnation with metallic salts*, such as mercury dichloride (corrosive sublimate), arsenical liquors, &c., and *heating in closed vessels*, a process which, though applicable to elementary substances, cannot be satisfactorily used for the preservation of corpses.

To avoid the use of poisonous substances whereby the toxicological search for such matters would be impeded or rendered of little avail in cases where such treatment might be requisite, various other preservative liquids, &c., have been proposed, *e.g.*, acetate of alumina, or a mixture of sulphate and chloride of aluminium, chloride of zinc, alcohol, creosote, &c., &c. A mixture of

Glycerine . . .	14 parts.
Crude sugar . . .	2 „
Nitrate of potash . .	1 „

preserves anatomical specimens satisfactorily. Glycerine, impregnated with carbolic acid, also answers well.

BRUNETTI proposed, in 1867, a process which answers well, but is very complex. Cold water is first injected by a syringe, so as to cleanse the vessels, &c.; then alcohol to remove the water; then ether to extract fatty matters; then a solution of tannin (about 15 or 20 of tannin to 100 of liquor); finally dessication by warm, dry air.

Certain Italian specialists prepare (by a process kept secret) anatomical specimens of the hardness of stone, yet perfect and unaltered, resembling the finest wax models.

For the temporary preservation of subjects, many substances have been used; hyposulphite of soda, sulphate of zinc, chloride of zinc, nitrate of potash, common salt, mercurial and arsenical preparations, alcohol, carbolic acid, &c., &c., being in frequent use. Sawdust or charcoal is often impregnated with carbolic acid or zinc sulphate and the corpse is covered with the prepared sawdust, &c. For cheapness coal tar is sometimes employed thus. *Moniteur Quesneville*, 1873, 453.

§ 5.—*Fuel, Illumination, Photography, etc.*

New Charcoal Substances.—The dust of charcoal of vegetable origin (not coke or coal dust) is mixed to a pasty consistency with solution of silicate of potash, and then formed into cylinders about 8 or 10 centimetres long, and 3 or 4 centimetres in breadth. These are then dried in a kiln, and are ready for use. The resulting fuel burns without smoke, and very regularly, giving out as much heat as ordinary charcoal. For many years there has been sold, under the name of "charbon de Paris," a substance composed of dust of charcoal, coke, anthracite, &c., made into a somewhat similar product by mixing with tar, forming into cakes, and calcining at a red heat. *Revue Hebdomadaire*, 1873, 219.

New Process for Gas Manufacture.—M. WILLIAMS of Wigan has patented (Jan. 17th, 1873, and April 19th, 1873) a new process for gas-making, which appears to possess great advantages in the matters of quality, cheapness, simplicity of manufacture, and an inexhaustible supply of raw materials. The invention consists in forcing steam and oil (more particularly hydro-carbon oil) together through a red-hot fire-clay or iron retort filled with coke, charcoal, or other similar substance. The retorts used are similar to those employed for the distillation of coal and cannel for gas-making. The steam and oil are rapidly converted into gas very rich in carburetted hydrogen and of high illuminating power. This can be used either separately as a means of illumination, or mixed with coal-gas in any proportion to increase its illuminating power. The gases can be most readily mixed, and the illuminating power almost regulated at will by

using a part of the retorts for this process while the other part may be employed in manufacturing gas in the ordinary way at the same time, and allowing the gases from both processes to become mixed in the hydraulic main, and to be purified together. The result of this mixing helps materially to increase the quantity of the coal-gas by carrying off the heavy hydrocarbons more rapidly, and thus lessening the production of tar. There is another important feature in this mixing, and that is, the coal used need not be "cannel coal," or what is now usually termed "gas-coal;" common caking coal will do, because the illuminating power of the gas does not materially depend upon the quality of the coal used, but is chiefly dependent on the oil-gas, the proportion of which can be increased or diminished as required. The chief advantages gained by this process (either alone or combined with that commonly adopted) are rapidity and economy in the production of gas of full illuminating power, and great facility in regulating the quality of the gas burnt. As the oil and steam are decomposed together, they form a gas of great permanency, *not liable to condensation*, and of great freedom from sulphur and other impurities, while the apparatus for producing the improved gas may be adopted at any gas-works with but slight expense, as it does not in the least interfere with the use of the retorts in the ordinary way.

Various schemes (mostly revivals of old processes) have lately been proposed, based upon the fact that light hydrocarbon oils or spirits (such as petroleum spirits, benzole, &c.) readily evaporate. If hydrogen gas or atmospheric air at the ordinary temperature be passed through these compounds, it becomes impregnated with their vapours to a greater or less degree, according to the temperature; if the hydrogen gas or atmospheric air, be now collected and burnt in a gas-burner, it will be found to illuminate; but unfortunately for the inventors of these processes, the carburized gases are not permanent, simply because the vapour present in the charged gas or air, being *only present as a vapour and not as a permanent gas*, readily condenses by coming into contact with a cold surface, or by exposure to a low temperature; hence the charged gases cannot be stored or carried for any distance on account of the condensation which thereby takes place, which greatly deteriorates, or even altogether destroys the illuminating power. Besides this, light petroleum spirits and analogous substances are dangerous bodies to use in manufacture on account of their great volatility.

These objections do not apply to the gas manufactured by Williams' process; the heavy oils, &c. there used are decomposed by the heat, giving rise for the most part to *permanently gaseous* illuminating substances, which are not liable to condensation, whilst the raw material is much safer for storage than light volatile liquids. A larger quantity of actual illuminating material can, it is said, be obtained from a given weight of heavy oil than can from the same quantity of light spirits.

Practical trials show a gain in many ways; gas of higher illuminating power than the best cannel gas can be manufactured at a less price than coal gas: considerable saving in labour and apparatus is effected; one retort will make 500 cubic feet of gas per hour continuously, without re-charging for some days, requiring little or no watching beyond the furnace being attended to. When made alone, the gas requires no purifying, as the raw material contains neither nitrogen nor sulphur.

Oxyhydrogen Light.—LE BLANC (Gas tester to the city of Paris), considers that the possibility of the manufacture of oxygen on a large scale is proved, but that the Companie Tessié du Motay has not been able to show any commercial economy, whilst the system is more expensive for lighting purposes than ordinary coal-gas. From 13 to 14 per cent. of nitrogen is usually found in the oxygen; to keep the manganate of soda serviceable, the air used must be deprived of carbonic acid; but it does not appear to be proved that the manganate will answer without revivification for a year; and it is doubtful if the use of oxygen instead of air in metallurgy would be of any use save for the fusion of platinum, &c. *Revue Universelle des Mines, &c. November and December*, 1872.

Exploration of the Oil Springs in Galicia.—A. FAUCK gives a descriptive sketch of these oil springs, comparing their mode of working with those of Pennsylvania, U. S. The Galician springs are not very big, the average yield of a single spring being about half a ton a day. *Polyt. Centralbl.* 1872, 1352.

Petroleum in Pennsylvania.—The "New York Semi-Weekly Times" says that in an old map, ordered by Parliament in 1771, and printed in a book of travels at that time, the petroleum deposits of Pennsylvania are all laid down and marked.

Argento-Images.—Professor HIMES briefly describes the preparation of these pictures by Wenderoth's process. The argento-image is simply a carbon-picture on silver. The carbon-paper, after having been sensitized in the usual way in the chrome-bath, is placed, gelatine downwards, upon a silver-covered copper-plate, previously wetted with dilute alcohol, and pressed. The development is, as with every other carbon picture, effected by warm water. *Polyt. Centralbl.* 1872, 1364.

Tenacious Collodion.—BOTTGER prepares a collodion of great tenacity, by dissolving gun-cotton in a mixture of equal bulk of absolute alcohol and ether, and then adding a small quantity of balsam of copaiba. When used on glass an extremely firm film is obtained. *Chem. Centralblatt*, 1872, 745.

§ 6. *Electricity, Magnetism, Telegraphy, &c.*

Action of Light on the Resistance of Selenium.—LIEUT. SALE has made experiments on this subject, corroborating those recently obtained by W. Smith ("Practical Magazine," page 281), viz. that the result of exposure to light is to diminish very greatly the resistance. The resistances of a bar 1·5″ × 0·5″ × 0·05″ in various parts of the spectrum were found to be,—

In darkness	330,000
„ violet	279,000
„ red	255,700
„ orange	277,000
„ green	278,000
„ blue and indigo	279,000
„ centre of red.	255,000
Outside edge of red (red side)	220,000
Dark rays clear of red	228,000
Diffused daylight	270,000
In the dark immediately after exposure (resistance rising)	310,000

The general results of the experiments are summed up thus:—

1. The existence of selenium is largely affected by exposure to light.

2. This effect is not produced by the action of rays, but is at a maximum at, or just outside the red rays, at a place nearly coincident with the locus of the maximum of the heat rays.

3. The effect of varying resistance is certainly not due to a change of temperature in the bar of selenium.

4. The effect produced on exposure to light is sensibly instantaneous, but on cutting off the light the return to the normal resistance is not so rapid.

Rays nearly coincident with heat rays of high intensity appear, therefore, to have the power of altering instantaneously with change of temperature the "molecular condition" of selenium. *Proceedings of Royal Society, xxi.* 283.

Chloride of Silver Battery.—GAIFFE patents the use of a porous material saturated with the exciting liquid in cases where chloride of zinc is formed, especially in the chloride of silver battery; the cells need not be hermetically closed to avoid spilling; there is no exudation outside, and local action is diminished. *Bulletin de la Soc. Chim. Paris, xix.* 526.

Electrostatic Phenomena of Piles.—BRANLY gives the details of a large number of experiments on this subject, and the mode of construction of a new form of electrometer used by him in his researches. *Revue Scientifique*, 1873, 1093.

Relation between the Electrostatic and Electromagnetic Units.—D. M'KICHAN has determined afresh the value of the ratio of the units of quantity in these two systems, which is such that this ratio is expressible as a velocity denoted by the symbol v. Weber found the value of v to be $310{\cdot}74 \times 10^8$ centimetres per second. Clerk Maxwell found 288×10^8; King, $284{\cdot}6 \times 10^8$; whilst the author obtains as mean result $v = 294{\cdot}5 \times 10^8$ centimetres per second; later observations made under more favourable circumstances giving $292{\cdot}4 \times 10^8$, and the latest of all giving the most probable result, viz.:—

$$v = 293 \times 10^8 \text{ centimetres per second.}$$

Proceedings of the Royal Society, xxi. 290.

Influence of the Aurora Borealis on Telegraph Wires.—The Parisian "Journal Officiel" records some facts which demonstrate that the conductivity of wires suffers very much during the display of the Aurora Borealis, and that often all telegraphic communication is interrupted. *Dingler's Polyt. Journ. ccvi.* 420.

New Ozone Generator.—T. WILLS describes a modification of Siemens' instrument, consisting of a glass tube of as cylindrical a bore as possible, with an annular tinfoil coating

outside; through the tube passes a cylindrical brass box carefully turned in a lathe and coated with tin, so as to resist the action of the ozone. The dimensions of this box are just a little less than those of the interior of the glass tube, so that when the brass is concentrically within the glass, a small circular air space is left between the glass and the metal. The outside tinfoil being connected with one end of the secondary wire of an induction coil, and the brass box with the other end, the gas in this circular space is subjected to the action of the electric effluvium. On passing dry oxygen through the apparatus a considerable proportion becomes converted into ozone; in order to prevent heating, a current of cold water is made to pass continuously through the brass box. The instrument (made by Messrs. Tisley and Spiller) is portable and not costly; it is not liable to get out of order, is not readily broken, and can easily be adapted to other pieces of apparatus. *Paper read before the Chemical Society, June 5th*, 1873.

Powerful Magnets.—JAMIN describes the method by means of which he prepares magnets that will lift twenty times their own weight; these are constructed of thin bands or ribbons of steel, such as is met with in commerce, a large number of such ribbons being superposed. *Moniteur Quesneville*, 1873, 438.

Researches on Magnetic Rotatory Polarization.—BICHAT has made a series of experiments on this point, from which it results that the magnetic power is the same in the case of a vitreous solid body as in its solution; that this power lessens as the temperature rises, and that in the gaseous state all trace of such action ceases to be manifest. *Revue Scientifique*, 1873, 1164.

§ 7.—*Miscellaneous.*

Tracing Paper.—Fine paper is impregnated with a solution of castor oil in three or four times its bulk of alcohol, the solution being applied by a brush. *Dingler's Polytech. Journal, ccvii.* 86.

Jute Paper.—The "Dundee Advertiser" for May 14th was printed on paper made of jute, the first time such an experiment has been made. The paper, though thin and transparent, and of rather a yellow tinge, is by no means bad, and after a few more experiments it will doubtless be much improved in quality. The quantity of jute suitable for the purpose, and now in the market, is considerable, and at the present price of paper the utilization of a material such as this would prove an immense boon. The paper on which the "Advertiser" was printed was made from old jute bagging, and it is said that the class of jute which will probably be found most suitable for paper-making, in respect of cost and production, is that known as "rejections," which can be bought in any quantity in Dundee at £9 10*s.* per ton. That, no doubt, is somewhat dearer than esparto, but while the outcome of paper from esparto is only about 50 per cent. that from jute may be taken at 70 per cent. so that the yield more than compensates for the difference of price.

By way of encouraging the manufacture, the proprietors of the "Advertiser" offer the following two prizes:—1st, A premium of £50 for the best ream of paper made entirely from jute suitable for printing their journal, of its average size and weight, and of which the maker will undertake to supply 50 tons at a price not exceeding 4½*d.* per lb. 2nd, A premium of £100 for the best ream of paper made entirely of jute, suitable for printing their journal, of its average size and weight, and of which the maker will undertake to supply 100 tons at 4*d.* per lb. *Journal of the Society of Arts, May 23rd*, 1873.

Production of Black Bricks and Tiles.—The dark blue, or often black bricks, occurring in some districts of the lower Rhine, are produced by exposing the more than half-burnt material to the influence of the dense smoke developed by burning green wood in well-closed furnaces. The carbonaceous gases take the oxygen required for their combustion from the peroxide of iron contained in the clay, transforming it into the proto-compound which imparts to the bricks the dark colour. This ordinary process must, however, be stopped when the evolution of the gases from the wood ceases, else oxidation sets in, reproducing the peroxide. The stopping is effected by pouring water on the outside of the furnaces; this penetrates partially into the interior and there forms steam.

The black clay goods manufactured in Staffordshire are of a superior kind, and possess, moreover, a thin salt glazing. *Dingler's Polyt. Journ. ccvi.* 347.

Utilization of Blast-Furnace Slag.—EGLESTON describes the process whereby blast-furnace slag may be obtained in devitrified masses of sufficient hardness to form a good road material, or in compact blocks suitable for building purposes; these processes mainly consist in very slow cooling in somewhat large masses.

The slag is sometimes granulated and used instead of sand for the pig beds, or mixed with lime for mortar (instead of sand); a rapidly hardening mortar is thus produced. Unburnt bricks covered with this granulated slag and then burnt (in kilns where carbon is not in contact with the bricks) become covered with a good glaze; pipes, tiles, earthenware, &c., may be thus glazed.

By blowing steam, air, &c., through the molten slag, fine threads or filaments are obtained, which are used under the name of *furnace wool* for packing boilers, &c. &c. *Dingler's Polytech. Journal, ccvi.* 457.

Gas Analysis.—C. WINKLER describes a new form of apparatus for the more rapid examination of gases for technical purposes. *J. Prakt. Chem.* [2] *vi.* 301.

Adulteration of Wax with Tallow.—HARDY finds that the quantity of tallow present may be approximately determined by finding the specific gravity of alcohol in which the substance examined will just float.

Alcohol strength.	Percentage of Wax.
29°	100
39·63°	75
50·25°	50
60·87°	25
71·50°	0

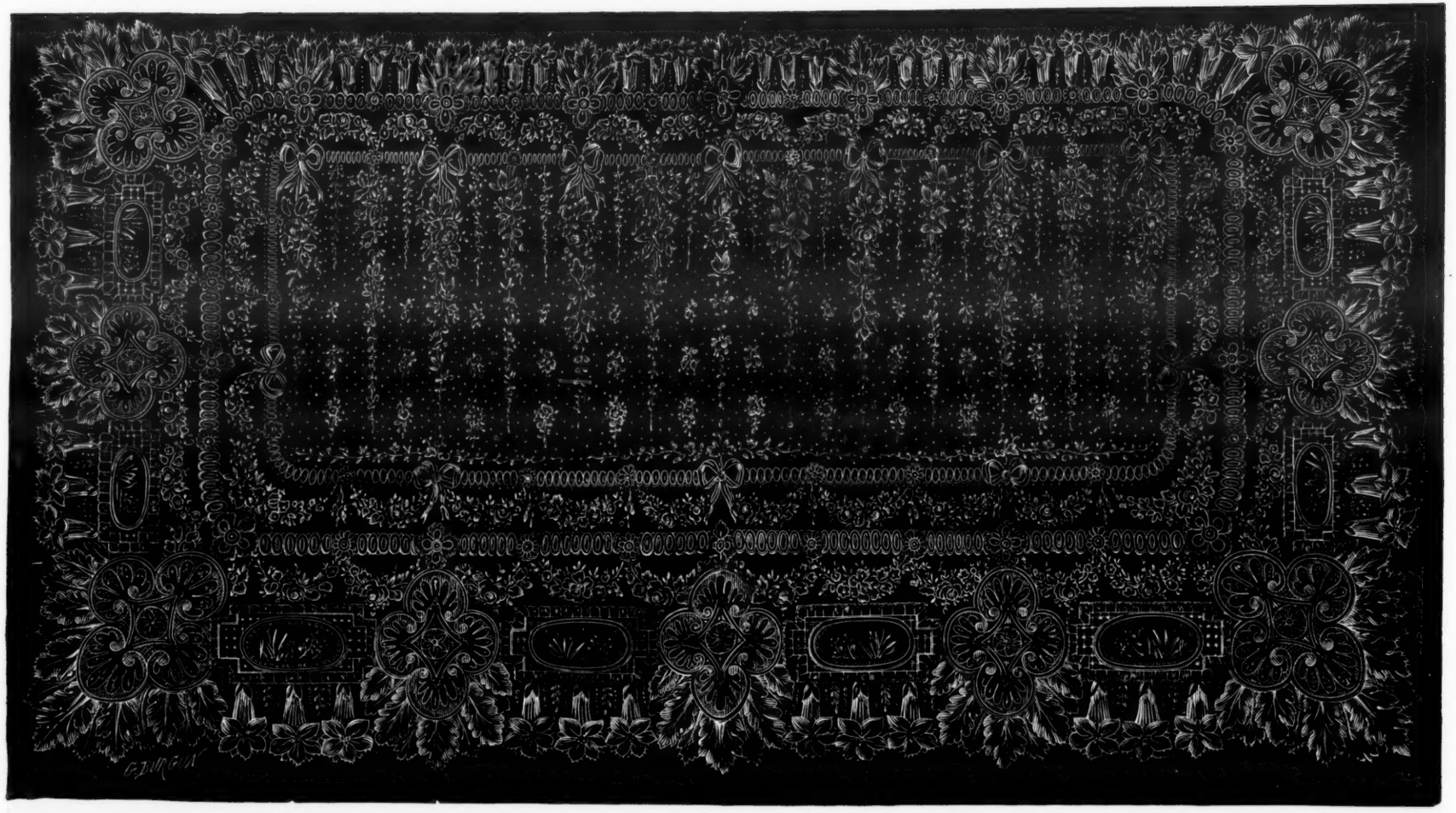
Chem. Centralblatt, 1872, 538.

Analysis of Glycerine.—CHAMPION and PELLET state that commercial glycerine, even though rendered perfectly colourless by the aid of animal charcoal, may yet contain considerable quantities of other substances, such as volatile fatty acids. Glyceric ethers, &c., formed by the action of the saponifying agents on pure glycerine, may be obtained by distilling glycerine formed by saponification with lime in superheated steam; at least, such glycerine very rarely contains impurities. The authors propose to estimate the amount of pure glycerine present by converting into nitroglycerine by means of a mixture of fuming nitric and sulphuric acids (1 of the former to 2 of the latter). 250 grammes of the mixture (best freed from nitrous fumes by heating to 80° and passing a current of air through) are placed in a vessel cooled externally, and about 30 grammes of the glycerine to be tested added drop by drop, taking care that the temperature does not rise above 25°. The whole is subsequently diluted with water, and the precipitated nitroglycerine washed with dilute caustic soda solution, treated with wood spirit, and finally evaporated to dryness. The wood spirit removes all water that may be present during its evaporation. Pure glycerine yields 190 per cent. of nitroglycerine by this treatment.

The headache occasioned by exposure to the vapours may be counteracted by ammonia or by acetate of morphia. The dangers of explosion are stated to be less than those commonly supposed. The nitroglycerine which accumulates during the analysis should be poured on sawdust, which absorbs it, and the dynamite thus formed thrown on red-hot coals. Under these circumstances the nitroglycerine burns away quickly, there being no danger of an explosion. *Bull. Soc. Chim. Paris, xix.* 493.

Valuation of Chloral Hydrate.—MEYER and HAFFTER dissolve the chloral hydrate in water, and then add a known volume of standard caustic soda solution. The chloral hydrate then forms formate of sodium and chloroform, so that a quantity of the soda is neutralized proportionate to the amount of chloral present. The amount neutralized is estimated in the ordinary way by determining the soda still left unneutralized and subtracting this amount from the total quantity employed. Should the chloral hydrate be acid naturally (from decomposition or imperfect manufacture), the process is still applicable, the free acid being first neutralized by agitating the aqueous solution of the chloral hydrate with carbonate of lime, and filtering before adding the soda. Check experiments, made with known quantities of pure substance, yielded satisfactory results. *Berichte der Deut. Chem. Ges. vi.* 600.

Manufacture of Carbonate and Bicarbonate of Soda.—SOLVAY patents a peculiar apparatus for the production of carbonate of soda from common salt by means of ammonia and carbonic-acid gas. The ammonia is constantly regenerated by means of magnesia, whereby a basic chloride of magnesium is formed. The bicarbonate of soda first formed is decomposed into neutral carbonate and carbonic acid, which is collected and used over again. *Bull. Soc. Chim. Paris, xix.* 479.



GEMS OF INDUSTRIAL ART.—MANTLE IN CHANTILLY LACE.

(*From the Establishment of Chauvreux-Aubertot, founded in* 1786.)

THE INDUSTRIAL DEPARTMENT OF THE LONDON INTERNATIONAL EXHIBITION, 1873.

REPORT ON CLASSES VIII. IX. XII. XIII. AND XIV.

[*By our Special Reporters.*]

MUCH has of late been said and written against the annual recurrence of exhibitions at South Kensington. This view has some semblance of truth, if exhibitions were to be regarded as mere matters of sightseeing. From a more practical point of view, such as is taken by those to whom this magazine addresses itself, they are of definite value. It is full well known what rapid advances are made in every branch of art and manufacture within the compass of a year; and thus it is to the large class who have a direct interest in one or the other of these various departments of technology that annual exhibitions, such as are organized by the indefatigable Mr. Cole, are of much importance.

From the tenor of these introductory remarks it will at once be apparent that the report we purpose to give will aim rather at being a carefully ascertained collection of facts than partake of the character of a *feuilleton*.

It should be stated at the outset that we have not contented ourselves with a rapid inspection of the objects on exhibition, but that we have endeavoured to procure the most detailed information from the first sources, whenever such seemed desirable We are glad to say that the steps we have taken for this purpose were greatly facilitated by the courtesy and attention uniformly shown us; and it could hardly have been otherwise, for the manufacturers of the present day are fully aware that there are very few, if any, processes or methods with which the man of theory is not acquainted, and that a generous disposition to aid the press in making industrial establishments known to the public cannot fail to bring advantage to themselves.

The industrial department of this year's International Exhibition includes the following classes :—

Class VIII. Silk and Velvet Fabrics, and some of the Machinery required in this industry.
" IX. Steel and Cutlery.
" X. Surgical Instruments.
" XI. Carriages.
" XII. Section A. Agricultural Products and Manures.
" " " B. Grocery, Drysaltery, and Preparation of Food.
" " " C. Wines, Spirits, Beer, and other Drinks; and Tobacco.
" " " D. Drinking Vessels, &c. Pipes, &c. Machinery employed in preparing or producing articles of Class XII.
" XIII. Cooking and its Science.
" XIV. Scientific Inventions and New Discoveries.

The present report will deal only with Class XII. In a succeeding article we will take up Classes IX. and XIV., and to a certain extent also VIII. and XIII.

The second and third sections of Class XII. embrace representatives of almost all solid and liquid materials which serve to build up and to sustain the human frame, and to delight the senses of taste and smell.

We naturally turn to that staple article of British food : meat. Great Britain and Ireland together do not produce food sufficient for the consumption of the population; in Australia, on the other hand, the production of meat is far in excess of that required. The following table, taken from the statistics drawn up by the Australian Meat Agency, gives the population and amount of live stock of the United Kingdom and the colony.

	United Kingdom.	Australasia.
Cattle . . .	5,624,994	4,772,980
Sheep . . .	27,921,507	51,028,152
Total live stock .	33,546,501	55,801,132
Population . .	31,817,108	1,919,303

The returns of the cattle and sheep in the United Kingdom and Australasia during the last four years are :—

	United Kingdom.		Australasia.	
Year.	Cattle.	Sheep.	Cattle.	Sheep.
1869 . .	5,313,473	29,538,141	4,339,615	46,268,093
1870 . .	5,403,317	28,397,589	4,712,118	51,292,241
1871 . .	5,337,759	27,119,569	4,810,351	53,680,752
1872 . .	5,624,994	27,921,507	—	—

In round numbers the United Kingdom has but one head of live stock to each man, woman, or child ; Australia has thirty. The United Kingdom contains one bullock to every six persons, Australia two and a-half bullocks for each person. The United Kingdom barely furnishes a sheep to each inhabitant. Australia produces nearly thirty sheep to every man, woman, or child it contains.

The stock of cattle in the United Kingdom does not increase, whilst, on the contrary, notwithstanding the population is daily growing larger, the live stock of Australia and New Zealand multiplies largely every year.

The following returns issued by the Board of Trade indicate the enormous increase which has taken place during the last seven years in the importation of preserved meats. These numbers do not include salted foods, meat extracts, or meat essences.

Year.	Tons.	Value.
1866 . .	4½	£321
1867 . .	336	£18,820
1868 . .	817	£44,746
1869 . .	1,415	£80,385
1870 . .	3,641	£203,874
1871 . .	11,853	£513,186
1872 . .	17,518	£890,700

The actual saving effected by the substitution of Australian meats for the probably very inferior qualities supplied by contract to our workhouses and gaols does not appear to be the only advantage arising from its introduction and general use in such establishments. There appear to be very substantial grounds for the belief that the wretched people to whom it is supplied actually show, with very good reason, a preference for the imported material ; while the mass of statements which the Australian Meat Company have collected and published testifying to its good effect—to quote one among many, that of the Rev. W. Clements, of St. John's Mission House, Mile End New Town, Stepney, that it not only "comforted the poor of his house, but built them up"—calls for unfeigned congratulation. What has been and may still be accomplished on the side of economy in the administration of hospitals, by enabling them to meet increased expenses arising from the great advance in the price of butchers' meat and other articles of diet, is apparent from the following reports of medical officers and secretaries of hospitals and other institutions where the preserved meat or the extract has been introduced.

The governor of Warwick County Prison estimates the saving from the use of Australian meat to be at least 30 per cent.

The surgeon of Manchester Gaol estimates the saving at 40 per cent.

The Royal Berks Hospital states the saving for 1871 to be £470 6*s.* 7*d.*

The Industrial School, Leeds, finds a saving, in one quarter, on a former expenditure of £66, of £35.

The Leeds Workhouse, a saving in one quarter, on a former expenditure of £478, of £89.

The master of Marylebone Workhouse, a saving in four days, on a former expenditure of £62, of £32 9*s.* 8*d.*

Carlisle Gaol, a saving in one half-year, on a former expenditure of £130, of £51.

Borough Gaol, Liverpool, a saving, on an expenditure of £1,500, of £750.

At St. Cuthbert's Parochial Board, Edinburgh, they estimate the saving at 5*s.* 9¾*d.* per diem on 389 inmates.

The superintendent of the London District School, Hanwell, finds the saving on each day's dinner for 1,124 children to be £5 3*s.* 6*d.*

In short, the saving by the use of Australian meat is variously estimated at from 30 to 50 per cent.

"Missionary," as the boys of the Royal Hospital School at Greenwich are stated by a contemporary to have named the tinned meat, has proved as acceptable wherever it has been introduced as Canon Kingsley could wish it to be. In Calcutta and Madras it has been received with a like welcome.

The Australian Meat Company, the purveyors of the Ramornie extract of meat and preserved meat, are well known to have been chosen some years since to supply meat to the Royal Navy, and this they continue to do. The company came into existence about eight years ago, and, according to the report of the "Sydney Morning Herald," commenced operations in the September of

the following year at Ramornie, a station on the Clarence River in New South Wales.

Little or nothing appears to have been known of this establishment until the pretensions to priority of a similar institution in a neighbouring colony brought the New South Wales industry to the front, the managers being probably engrossed in the development of their plans.

The present flourishing township collected around the meat-preserving works on the banks of the Orara owes its origin to a boiling-down establishment which existed at that spot for some years, the present establishment being in some sort a development of that. "Ramornie" was the designation of the run, and the station is about thirty-five miles above Grafton—following the course of the river—but the works are not more than nine miles from South Grafton as the crow flies.

Ramornie has a great advantage in that it is so easily accessible to the cattle stations to the north, which are among the first in Australia. Not only is the country well adapted for cattle, but, what is scarcely less important, many of the principal owners have shown great enterprise in the importation of first-class animals, and have been careful to improve the breed of their stock. The works are erected close to the banks of the river, which rise to the height of about 40 or 50 ft. above the present level of the water, and the ground, which is of sandstone formation, gradually runs into stony ridges at the back of the settlement.

Some idea of the magnitude of the company's operations may be formed from the fact that already in 1871 they gave constant employment to 150 men at Ramornie, and that the weekly shipment of preserved meat to Sidney for exportation to England amounted to 150 tons. A description of the slaughter of the beasts may as well be passed over, but it should be stated that the "pithing" is considered to be almost instantaneous and painless. The abattoir is connected with the yards where the cattle are kept which are for the day's killing, the remainder of the stock on hand being driven on to the best of the run until required. On one side of the pithing-house is a room for the salting of hides, and another where the carcases are dressed. Five men can kill and dress ten bullocks per hour. The carcase is transferred to the cutting-up room, where two men are sufficient to perform the work of dividing the animal into the various parts suited to the different processes of manufacture carried on.

The meat from which *extractum carnis* is to be made is put into mincing machines, which are worked by steam, the choppers descending vertically upon a circular wooden block or basin, which is kept constantly revolving by steam power. From the choppers the meat is introduced into boilers of large capacity, and these are kept boiling a sufficient time to extract the greater part of the essence. The fibrous portion of the meat is afterwards subjected to hydraulic pressure, which expresses the remainder of the juice.

Two years ago the company was making extract at the rate of about twenty-five tons in the year. This is packed in small square iron chests, each containing about 200 lbs. For this there was a ready sale at 10*s.* per lb., so that a chest of almost insignificant proportions represents £100.

The extract is invaluable by reason of the enormous amount of nutriment which it contains compressed into the smallest possible compass. Twelve pounds weight of strong extract represents the nutritive portion of a whole bullock.

The portions of the carcase destined to leave the establishment as preserved meat are taken from the cutting-up room to the scales, where they are weighed and placed in the tins, the actual weight of the raw meat placed in each tin being considerably more than the weight which is sold; it requires fully 7 lbs. of uncooked meat to fill a canister which is sold as 6 lbs. The tins, which are specially prepared for the reception of the meat, are carefully soldered, a small hole being left in the top of the canister to allow the air to escape. Large baths, each capable of holding one hundred tins, are packed with that number and filled up with a concentrated solution of calcium chloride, which is heated by means of pipes of superheated steam that traverse the baths for the purpose. When the steam generated in the tins has expelled all the air they contain, they are hermetically closed with solder and transferred to vessels of cold water to arrest the further action of heat on the animal tissues. The tins are then tested to insure their being air-tight, and of which it is stated there are not more than two or three in a thousand, and the defective ones returned to the boiling-house, that their contents may be made up afresh. The sound tins are cleansed with water and sawdust, painted, labelled, and packed ready for shipment.

Other parts of the carcase serve for the production of tallow, marrow, &c., and the hides, bones, horns, &c., are likewise made a source of income.

According to the latest particulars, with which we have been favoured by the secretary of the company, the average number of bullocks killed at Ramornie is 9,000 per annum; a great number of sheep and pigs are also slaughtered and tinned. The tin plates for the canisters cost over £1,300 per annum, and the freight of the cases shipped to Europe over £7,000 per annum. The systems adopted in the preparation of the meat are partly that known as Appert's process, and the method of digesting the baths of calcium chloride. Nearly two hundred men are at present kept in constant employ, exclusive of lads and boys, and for the education of over fifty of the latter a well-appointed school was founded some years since.

Messrs. Whitehead and Co., of Lime Street Square, London, import their tinned meat from Broadwater, on the Clarence River, New South Wales, and make a speciality of producing, in addition to beef, boiled, corned, and minced, and boiled mutton, ox cheek, ox tail in jelly, ox tongues and stewed kidneys. They state that their exhibits are made from the finest short-horned herds of Australia, the original stock having been imported from the best breeders in England. Another peculiar feature of their trade is the introduction of the solid essence of meat, one pound of which is made from thirty-two pounds of beef free from bone, and which is equal in point of nutriment to forty-two pounds of butchers' meat. All the phosphates and other soluble saline constituents of the greatest value for the building up of bone and the renewal of lost tissue are preserved in the essence. The solidified soup squares of Messrs. Whitehead and Co. possess the great advantage of being more condensed and compact than the soups as ordinarily prepared. Sixteen squares, each of which can be made into a pint and a-half of soup, occupy the same space, and have, in fact, the same weight, as a one-pint tin of preserved soup. Each square contains the nutritious ingredients of a pound and a-half of fresh meat, as well as the vegetables and other materials necessary to give it a distinctive character. Under the name of "Gargantua" they sell squares of a stew of meat and vegetables, each one of which will make four pounds of pot-pourri. This article of food consists of fresh beef, vegetables, the solid essence mentioned above, and various condiments to give them flavour. They likewise produce mixed compressed vegetables which retain their original colours.

The Australian Meat Agency Company have so far developed their scheme of providing dinners for working men that they can now supply them of the kind originally prepared at Norton Folgate at any part of the City. A powerful steam-cooking apparatus has been erected at Norton Folgate, and the meats, packed in vessels that retain the heat, and provided with the necessary spoons, plates, &c., are sent by an organized corps of men to the wharves or factories as required. The dinners are supplied hot, and vary in price from 1*d.* to 2*d.* Uncooked dinners are also sent out in the early part of the day, and consist of barrels containing Australian and English fresh meat, with the vegetables, herbs, and condiments required for making Irish stew, pea soup, Scotch broth, &c. The whole of the materials are prepared ready for use, and have merely to be boiled in a saucepan of water in the regular manner. These "Family Meals" for six or twelve persons cost 6*d.* and 1*s.* respectively. An experiment for the purpose of practically testing this system of preparing and expeditiously distributing meals ready for cooking is to be tried at the Australian Meat Agency Company's Department in the International Exhibition during the present summer.

Among the last novelties introduced by this company are spring lamb, uncooked beef steaks, kidney soup, vegetable soup, stewed kidneys, stewed tripe, corned ox-tongue, corned mutton, and smoked mutton in joints. Another welcome kind of food is Australian butter, in firkins, which is pronounced to be of excellent quality, and is saleable wholesale at 9½d. per pound.

The Central Queensland Meat Preserving Company have their works on the Fitzroy, within four miles of Rockhampton, the second largest town in Queensland. The Fitzroy River is navigable as far as Rockhampton for vessels of 500 or 600 tons, and communication with the sea is also maintained by means of the mail steamer. This river drains a country as large as England in area, the greater portion of the district being good grazing land. The coast is well adapted for fattening cattle, and the salt bush-runs in the interior afford pasture to sheep of very large size.

This company at present only supplies beef and fish, barramundi. Among their more special produce are minced collops, rump steaks, and ox-tail and kidney soups.

Besides the above-mentioned exhibitors, the firms given below exhibit the specialities which follow their names:—

Derby and Gosden, London—Fluid meat.

Joseph Fanitz, Paris—Preserved tripe.

Food Preserving Company, Houndsditch—Preserved meats and model.

J. Hogarth, London—Australian cooked meats.

J. L. Johnston, Edinburgh—Preserved and savoury meats in skins and tins, smoked meats, beef in powder, meat biscuit, etc.

Kaltenbach and Schmitz, London—Preserved Australian meats.

J. McCall and Co., Houndsditch—Preserved meat and extract of meat.

Tooth's "Liebig's" Extract of Meat Co., London—Extract of meat.

It may not be out of place to reproduce here a description, given by Liebig some years ago, of a special soup for invalids, but which is less known than it deserves to be.

To prepare this soup, half a pound of meat—beef or chicken being preferable—is chopped in fine pieces, and mixed with one and an eighth pound of distilled water, containing four drops of hydrochloric acid and a drachm or half a drachm of common salt. After the lapse of an hour the mixture is thrown on an ordinary hair sieve, and the liquid strained off, without any pressure being used in its separation. That which passes through first is turbid, and is returned to the sieve till the solution is obtained clear and fine. The contents of the sieve are then to be shaken up, in small portions at a time, with half a pound of distilled water.

In this manner a pound of cold meat extract is obtained of a red colour, and with an agreeable flavour of the meat. It is to be given cold to invalids; if heated it becomes turbid, and a dense coagulum of meat albumen separates.

A case of typhus fever in a young woman eighteen years of age in his own house was the immediate cause which led Liebig to try this kind of food. At a certain stage of the disease the powers of digestion became greatly reduced through the condition of the intestines, and the want of a material readily convertible into blood was in the highest degree desirable. In the kind of soup usually prepared by boiling the constituents of meat most serviceable in forming the albumen of blood are entirely wanting, and the yolk of egg which is usually added contains but little of the desired material, as it consists of 82½ per cent. of water and fatty matter, and only 17½ per cent. of albumen of egg or analogous substance, and that this indeed possesses the same nutritive power as the albumen of meat has by Majendie's experiments been shown to be highly improbable. In addition to meat albumen the soup proposed by Liebig contains a certain quantity of the red matter of blood, and consequently a greater amount of iron necessary for the building up of blood corpuscles, and lastly the hydrochloric acid requisite for digestion.

The chief difficulty to be met with in the preparation of this kind of soup in summer arises from the ease with which it undergoes a change in warm weather; it as readily ferments as a sugar solution with yeast, without, however, developing any unpleasant odour, and the result of the change is at present not well understood. The extraction of the meat therefore must be conducted in a cool place with very cold water. When ice water is used and the meats are cooled with ice no difficulty arises. It is, it need hardly be stated, of the greatest importance that the meat be absolutely fresh.

Liebig mentions a case of a patient suffering from ovarian inflammation who was unable to take any solid food whatever, and who was kept alive, recovered health, and gained flesh, solely by the administration of this kind of aliment. As a rule patients entertain no dislike for the soup till they are sufficiently recovered to desire food with stronger flavour, and at any time any objections then arising from its want of taste or to its colour may be overcome by adding to it some burnt sugar or a glass of good claret.

The bye-products of the present meat trade call for some mention. At present little or nothing has been done towards turning them to account, and according to the "Australian Meat Agency's Trade Reports," the entrails, gut, and bladders which might be utilized with considerable advantage and profit, are cast away. In England the "runners" are carefully collected, and after the gut has been thoroughly cleansed it is employed either in the manufacture of skins for filling sausages, or for the manufacture of violin strings. The bladders are used for packing lard and cheese. The feet of cattle and sheep when boiled for many hours furnish neat's-foot oil, one hundred sets of feet producing about eight gallons of an oil largely consumed in the leather trade, as well as for the lubricating of machinery.

As yet no suggestions appear to have been made for the preparation of albumen from the blood which must form so abundant a waste product at these slaughtering establishments. This substance, for which there is a steady demand at the large dyeing works in the North of England and elsewhere, is at present manufactured for exportation in limited quantities only in Germany. Ox blood at present is the chief source of the albumen prepared; the blood of sheep, however, contains this substance in a greater abundance and in purer form.

We next inspect a number of cases and stands showing a rich variety of farinaceous preparations, and the materials they are derived from.

Biscuits in all shapes and sizes are exhibited by our well-known home manufacturers, Peak, Frean, and Co., of Dockhead; R. Middlemass, of Edinburgh; D. S. Sutherland, of the same place; Huntley and Palmers, of Reading; and Gray, Dunn, and Co., of Glasgow. It would almost appear as if these establishments could not fulfil all expectations either in quantity or quality, for a large number of foreign competitors present themselves with beautiful specimens at South Kensington. We notice specially E. Barbot, of Rheims; H. J. Feith, of Upsala; L. Rouvier, of Marseilles; and O. Weirsoe, of Hobro, Denmark.

Maizena, oatmeal, cornflour, semolina, and various other prepared specimens of flour, are shown by the Glen Cove Co., U.S.; Foulds, Gilmour, and Co., of Paisley; and W. Hay and Son, of Glasgow. Several makers exhibit self-raising flour; this is flour mixed with some dry fermenting material, in most cases dried beer yeast, with some hop, and occasionally with ground malt.

In addition to the cardinal articles of food which have been enumerated, there are a vast number of secondary alimentary preparations of which no more than a passing mention can be made.

Craig and Co., of Southwark, exhibit a congested compound called "Patent Solid Pea-soup," which might haply demand the aid of "Concentrated Wine," as exhibited by Gagnière, of Lyons, or the "Consolidated Tea" of Goundry and Co., for its complete digestion. Of fish and fowl we have representatives: anchovies from H. Bergström, of Lysekil, in Sweden, and Carl Fust, of Christiania, as well as herrings from Throndhjem, while J. V. Halford, of St. Martin's Lane, makes a speciality of curried fowls in tins. Gâteaux bretons, foies-gras with truffles of Périgord, truffled game, and other kickshaws to delight the gourmand, are shown by some half-dozen French houses; while, as a set-off against these toothsome delicacies, another firm, unabashed, directs our attention to eight sorts of chicory "shown for their beauty and superiority of quality." Sweet things and sour also of every kind abound: jams, marmalades, curry-stuffs, the innumerable varieties of sauces and relishes; honey from Oporto, white honey and hydromel from Thumbroune; biscuits from Chablis and Angoulême, "mignonette" biscuits, even "manna biscuits" from the *Ladies' Work Society* in North Audley Street, and "effervescing lozenges," calculated to make the busiest tongue to cease from wagging for a season, vie with preserved tripe, oil-cake, and "antiscorbutic ship biscuits." We at last find among the preparations of food, "vegetable bread," "inoxidizable fat," wax fruit, and are bound to admit that our powers of classification and criticism have a limit.

Among the farinaceous fancy articles we find quantities of maccaroni, the manufacture of which is carried on within the Exhibition building (ground floor) by swarthy looking men in red Lazzaroni caps. The wondrous forms of wedding-cakes, some of which appear as the solidified and preserved transformation scene of a Christmas pantomime, must of course be also mentioned, though we believe they ought to have been placed in the Fine Arts Department.

Pure varieties of vinegar are exhibited by H. Allnutt and Co. of Bermondsey, and E. Barré of Bonny-sur-Loire (France). The first named firm represents the factory of A. B. Blaess in Antwerp which produces its vinegar from malt alone. The article is very concentrated and, according to analyses, free from oil of vitriol and pyroligneous acid.

The French exhibitors' product is derived from wine by the old-fashioned process of inducing the acetic fermentation with micro-dermous animalculæ.

We now come to the remarkable triad group of coffee, tea, and cocoa. At one time scientific men were at variance whether to classify these substances as food or simply as stimulants. It seems that they serve the body in both senses. The highly nitrogenized bodies, caffeine, theine, and theobromine, which they contain, cannot but be regarded as blood-formers, whilst they, in connection with some of the as yet little known aromatic constituents, exercise also a pronounced influence on the nervous system.

It may be interesting to quote here some observations on the physiological action of the chief constituents of tea and coffee, made a short time ago by Dr. Clapton, of St. Thomas's Hospital.

"There are three principal substances in tea. First, a *fragrant volatile oil*, which, in excess, is very poisonous, having a powerful narcotic as well as a subsequent sedative influence; but in moderate quantities it is stimulating to the brain and spine. Experiments were conducted by Dr. Lettsom, showing that it induces paralysis of the hinder extremities of a frog, and when injected into its abdominal cavity even causes death. It is this oil which produces in the human subject the peculiar intoxicating

influence of strong green tea. Second, *tannic acid*. It has not yet been ascertained what effect this theo-tannin has in the system when taken in combination with the other ingredients of tea, or whether it in any way promotes its neurotic or nutritious influences. Certainly it in no degree acts, as has been suggested, as an alvine astringent. Third, *theine*. On an average, the teas of commerce contain about 2 per cent. of theine. It is a crystalline substance which sublimes when heated, and is soluble in both water and alcohol. It possesses a slightly bitter taste, but scarcely any odour. It contains a large percentage of nitrogen. As to its action in the system, it is generally agreed that it tends to arrest the rapid consumption of tissue both by retarding decay and promoting renovation, thus relieving the feeling of exhaustion which is brought on by protracted mental or bodily labour. That it has this power of lessening the waste of the body is shown by the diminished formation of urea which takes place under its use.

"It has also been asserted that less phosphoric acid and carbonic acid are excreted from the system, and that there is diminished daily exhalation, both pulmonary and cutaneous. Now, if this be so,—that the effect of taking a few grains of theine daily into the system is to moderate combustion, and to lessen the absolute quantity of all those substances which are daily excreted—then it must follow that less assimilable food will be necessary in order to replace that which is wasted. Tea, therefore, economises food, and the appetite is satisfied by a smaller allowance, whilst at the same time the over-active bodily functions are tranquillized, and the mind is exhilarated. Last year Dr. Aubert described some experiments on animals, with respect to the properties of theine or caffeine. He found that by this alkaloid reflex excitability may be increased and even tetanus produced, muscular excitability not being affected as long as the caffeine is not applied to the muscles themselves. By the injection of a full dose there is produced at first an increase in the frequency of the pulse, but a diminution of its bulk takes place very quickly (one minute after the injection), and sometimes determines the immediate death of the heart. The increased rapidity in the heart-beats and the rise of arterial pressure observed, may be attributed, Dr. Aubert thinks, to a paralysis, more or less complete of the nerves proceeding from the ganglia to the muscles of the heart, and an excitation of the arresting apparatus of the heart. He does not agree with those who say it is caffeine which gives to coffee its principal qualities. He thinks the reviving action of coffee, which makes it such a favourite beverage, is not yet sufficiently explained. Professor Johnston states that half an ounce of good tea (which contains about four grains of theine) may be taken in a day by most full-grown persons without unpleasant effects; but if twice this quantity, or eight grains a-day, be taken, the pulse becomes more frequent, and trembling comes on; at the same time the imagination is excited, and after a while the thoughts wander, imaginary visions begin to be seen, and a peculiar state of intoxication comes on. Lehmann found that an over-dose produced violent excitement of the nervous and vascular systems, frequent and irregular pulse, palpitation, cephalalgia, tinnitus aurium, sparks, sleeplessness, and delirium. According to Liebig, theine, in moderation, contributes to the formation of taurine, the nitrogenized constituent of bile, and in this way is useful in some hepatic affections in which there is a diminished biliary secretion."

The following is, according to analyses made by *Playfair* and *Lankester*, the composition of the three products in 100 parts:

	Tea.	Coffee.	Cocoa.
Water	5·000	12·000	5·000
Theine	3·000	—	—
Caffeine	—	1·750	—
Theobromine	—	—	2·000
Casseine	15·000	13·000	—
Albumen	—	—	20·000
Aromatic oil	0·750	0·002	—
Gum	18·000	9·000	6·000
Sugar	3·000	6·500	—
Fat	4·000	12·000	—
Butter	—	—	50·000
Tannic acid	26·250	—	—
Woody fibre	20·000	35·048	4·000
Mineral matter	5·000	6·700 4·000*	4·000
Starch	—	—	7·000
Colouring matter	—	—	2·000

* This figure represents the potash salt of a peculiar acid.

Of the first two we shall not say much. Their treatment, preparatory to household use, is of too simple a nature to be numbered among the chemical industries. Trials have been made with the view of bringing both coffee and tea into a readier form for use than the natural productions, but as yet the consumption of such artificial preparations is very small. Under the names of Essence of Coffee, Extract of Coffee, Extract of Tea, &c., aqueous decoctions of these substances, more or less concentrated, or even dried to powder, and mixed with sugar and milk, or without such, are to be met with in the trade. Exhibitors of preparations of this kind are Dunn, Hewett and Co., London; The English Condensed Milk Company; T. and H. Smith and Co., Edinburgh.

The sources whence tea and coffee are derived, the coffee plant (*Coffea arabica*) and the tea shrub (*Thea sinensis*) are, we think, sufficiently well known to allow of their being passed over here without further notice.

Dr. A. Campbell, Slough, Bucks, and Harrisons and Crosfield, London, exhibit rich collections of varieties of teas; Goundry and Co. show squares and blocks of consolidated tea; coffee, raw and roasted, as also the process of roasting is shown by J. Lyle and Co. of Bond Street; Tovery, Phelps and Co. have an assortment of Brazilian coffees (grown on the estate of Chevalier Mansel da Rocha, Leao) on show.

In greater preponderance over the tea and coffee exhibits stand those of cocoa. Of course this circumstance cannot be taken as indicative of cocoa being more largely consumed than the two other allied forms of food; but we suppose it is indicative of the rapid increase in the use of cocoa. This substance demands a greater treatment than either tea or coffee before it is ready for use. All descriptions of cocoa and chocolate have for their base the nut derived from the *Theobroma cacao*, Linn., a tree occurring in Mexico, Central and South America, and the West Indian Islands. The process of manufacturing the various forms of cocoa, chocolate, &c., is effectively shown at the Exhibition by the Compagnie Française, of Bermondsey New Road; but we have preferred, for the sake of describing this process, to pay a visit to the works of Messrs. Dunn, Hewett and Co., at Pentonville Road, in order to satisfy ourselves whether the everyday work is quite the same in point of neatness and manipulatory skill as that done specially for inspection.

The process commences with the sorting of the nuts, the picking out and separating of mouldy, worm-eaten, or defective nuts. This is done by girls who sit at a sort of desk, the top of which is an inclined grating, on which the nuts are spread out. The next operation, the roasting, is conducted in metal cylinders with holes at each end, through which the vapours generated are allowed to escape. These cylinders, which are made to revolve gently over a slow fire, have in their interior a special contrivance for changing the relative position of the nuts, and thus to impart to the whole of them an uniform heat. The roasting is considered to be finished when the nuts have acquired a rich aroma and become brittle, and this is usually the case after the lapse of about an hour or an hour and a-half.

The roasted nuts are placed on open wirework coolers, and, when cold, are brought to the so-called "kibling mill," where they are just sufficiently bruised to free the nibs from the skin. The separation of the husks is effected by winnowing fans placed below the cylinders. The nuts are now ready for grinding, and they leave the mill in a semi-fluid state. This mass, after spontaneous drying, breaks up into powder, which is now worked up into all the varieties of cocoa and chocolate. To produce soluble cocoa, an invention of Mr. Daniel Dunn, one of the founders of the firm of Dunn, Hewett and Co., the ground nuts are mixed with sugar and farina, by the latter name arrowroot flour being chiefly meant. By an admixture of Iceland moss the well-known "Iceland Moss Cocoa" is produced; while, by the addition of Indian corn-flour, "Maizena Cocoa" is obtained. Both these preparations require boiling with water for a short time before being used as food, while the above-named soluble cocoa need not be boiled, but merely stirred with hot water. Under the names of "Carracatina" and "Bromatine," two varieties of cocoa which have been freed from the natural butter of the nuts are likewise prepared.

The manufacture of the well-known chocolate-creams deserves a word. Flat trays are filled with tightly-pressed starch; this bed of starch is indented at regular intervals with small pits, into which is filled a warm syrupy mixture of gluten and sugar. As soon as these drops have solidified, they are shaken out of the starch bed and collected by a number of little girls, who roll them in a paste of chocolate with their tiny fingers.

The final stage of the process is of course the drying of the various varieties of cocoa and packing them for the market.

Beside the above-named, the following firms exhibit preparations of cocoa:—Dottridge and Co., of London; J. S. Fry and Sons, of Bristol, who, we believe, are the oldest manufacturers of these forms of food; C. J. Grafstrom, of Stockholm; E. Guillon, of Paris; R. E. Jones and Co., of London; A. Joveneau, who also exhibits Racahout; Matias Lopes, of Madrid; Louit Fieres and Co., of Bordeaux; H. Schweitzer and Co., of London; H. Thorne and Co., of Leeds; W. Tulloch, of London; while the very fine and pure soluble cocoa of Van Houten and Zoon, of Weesp, in Holland, is exhibited by H. Eschwege, of London.

This cocoa requires the addition of no milk, and contains no farina or sugar, and has been found on analysis to be unusually rich in alkaloid. One pound of the manufactured material suffices to make 100 breakfast cups of cocoa.

A few words should find a place here about the various substances which under the designations of chicory, roasted barley, roasted acorns, &c., are proposed as substitutes for coffee, but which in their chemical composition and physiological functions have about as much in common with coffee as coffee itself has with the paper in which it is generally sold. There are several exhibitors of tempting articles of this kind whom we do not enumerate.

All these three articles are usually taken with milk, and this naturally leads us to treat in this place of the various preserved forms of this article of diet. We wonder if it occurs to persons—more especially Londoners—who gaze at the piles of milk-tins at the International Exhibition, how great is the boon they enjoy in being able to procure the pure condensed material from the Alps stored in these compact little vessels! We have but to think of the nameless horrors systematically sold under the name of "milk," especially to the lower classes of London—and we are reminded of Tennyson's lines :—

> "While chalk, and alum, and plaster, are sold to the poor for bread,
> And the spirit of murder works in the very means of life."

One of our worst outbreaks of typhoid fever in a thickly populated London district was of late finally traced by a skilful medical analyst to a pump with which the milk supplied there had been diluted with water containing typhoid germs! Leaving out of consideration, however, the ordinary dilution with more or less impure water—bad enough in any case, especially when the milk is to be used by sick persons and young children—the milk of London, drawn as it is to a considerable degree from stalled cattle, contains a deficiency of those nutritive constituents which abound in that supplied by pasture-fed cattle, and it is exclusively from such sources that the milk which is concentrated and tinned by the Anglo-Swiss Milk Company and the English Condensed Milk Company is derived. The processes of these establishments have been described in a former number of this magazine (see "Practical Magazine," No. 5, page 256). We will therefore merely point out that to the concentrated milk, sugar in one form or other is added. The Anglo-Swiss company employ purified grape sugar for this purpose; in what form the English company introduces the sugar we do not know with certainty. In reply to our inquiry, the manager of the English Condensed Milk Company states, that their product contains neither glycerine nor any glucose. They employ, therefore, probably cane-sugar.

Some manufacturers evidently use glycerine in the place of sugar, for a patent was taken about a year or more ago in which the use of that substance for the purpose is described. Glycerine, though innocuous, is a compound widely differing from sugar and other glucosides, and certainly is no normal constituent of milk. It is a question, therefore, how far its introduction can be considered justifiable.

Mr. Hooker, of West Horsley, Surrey, another exhibitor, describes some experiments which indicate the stable character of the milk preserved by him at West Horsley. One sample which had been made on the 29th December, 1867, was freely exposed to the atmosphere in an open vessel for more than two years without undergoing any change whatever. It was kept in a pantry where milk during the hot summer of 1870 repeatedly turned sour. In August, 1870, a portion of this sample was diluted with water and cream raised, and butter was made from it on the following day. The original sample was again examined in October, 1871, and it was found that no decomposition had taken place. Sugar is the only ingredient added at this exhibitor's establishment.

We give below, for comparison's sake, analytical tables showing the average composition of ordinary cow's milk and the condensed milk, the latter being as quoted from the "Lancet :"

One hundred parts of the former contain—

Milk sugar	5·3
Caseine	3·8
Butter	4·4
Ash	0·3
Water	86·2
	100·0

One hundred of condensed milk consists of—

Milk sugar	16·2
Caseine	15·2
Butter	11·7
Ash	2·3
Water	25·1
Cane sugar	29·5
	100·0

Preserved milk is often infused with other substances, as with cocoa, coffee, tea; and M. C. V. Viard, of 48, Boulevart Malesherbes, Paris, even exhibits, among other things, a mixture of condensed milk with the salts of Vichy water.

We now come to the third section of Class XII., which includes, among actual articles of food, wine, beer, spirits, and other drinks not alcoholic. In spite of the almost universal use of alcoholic liquids, the general public appear to possess very little accurate knowledge respecting their nature and function. Indeed, there are persons who stoutly deny that these articles may be regarded as food in any sense. Eminently classical authorities, however, think differently. Liebig, in his celebrated "Chemische Briefe," states that alcohol stands next to fat in point of importance in the respiratory processes; its use is attended by a corresponding diminution in the consumption of farinaceous and saccharine food. While the two last-mentioned substances require several hours for their assimilation, alcohol and its congeners are taken up most rapidly. In addition to this action, all fermented drinks produce, through the agency of the nerves, increased activity of the brain and spinal cord. Liebig beautifully illustrates the correlation of amylaceous forms of food and alcoholic drinks by a quotation from Shakespeare's "King Henry IV."

"*Prince Henry* (*loq.*). O monstrous! but one half-pennyworth of bread to this intolerable deal of sack!"

Among the drinks on exhibition at South Kensington, beer, as a beverage peculiarly English, calls for the first mention. A knowledge of the process of its manufacture, as at present conducted, can be gained in no more agreeable manner than by an imaginary visit to one of our large breweries. Messrs. Younger and Co., of Edinburgh, have courteously supplied us with a detailed description of their establishment, and a part of this we purpose to incorporate here.

The establishment consists of two works, the Abbey, or principal brewery, at the Canongate, and the new brewery of Holyrood. The Abbey Brewery, in which more than half the ale manufactured by the firm is produced, has a specially advantageous site; it enables the firm to obtain from wells underneath the premises an abundant supply of beautifully clear water, possessing properties which have proved it to be excellently adapted for brewing purposes. Entering by the chief gateway of the works, we find above and on either side the counting houses, business rooms and apartments occupied by the several members of the firm. The huge square block in front, and extending backwards in a south-westerly direction, comprises what may be called the working premises. These buildings are of three storeys. The portions in which the malt is prepared are situated in the wings of the block, but are here of comparatively limited extent, the principal maltings, which are made to supplement the supply of material both to the Abbey and the Holyrood breweries, being situated at Canonmills. As we enter the building at the Abbey Brewery we see a number of workmen engaged in emptying from carts several loads of malt which had undergone the various processes of steeping, growing, withering, and drying on the kilns at Canonmills, into a large wooden receptacle attached to the outside of the wall in the courtyard, and protected by a wooden roof overhead; the malt is emptied from the bags. As it reaches the narrow neck at the bottom of this receiver the malt is carried away by a hoist, which, working by steam power on the principle of a dredging machine, empties itself into a large "holder" on one of the upper floors. From this the malt is allowed to descend in a regulated flow on to a sieve or screen, the purpose of which is to cleanse it from the growth, as well as dust and other impurities, and thence it finds its way by spouts to an apartment on the ground floor. Passing between a couple of heavy revolving cast iron rollers, it undergoes the process of grinding, the motive power being supplied by a 12-horse horizontal engine. The malt then again ascends by closed elevators to the "hopper" on the third floor of the building. From this "hopper" it progresses down through an aperture into a conduit leading to the steam-working mashing-machine, having spikes at the back on a screw, by which, in the process of mashing, the malt is propelled until it is discharged into either of two large copper mash-tuns on the second floor. These tuns are capable of working about 150 quarters per diem. The requisite quantity of mashed malt having been deposited in each tun, a stream of boiling water from a huge close boiler overhead mixes in a certain proportion with the malt. Here is one of the secrets, for the

utmost care is required to regulate the temperature; and a certain degree of heat having been attained, the tuns are closed at the top, and for about two hours the "mash" undergoes the process of "washing." This completed, the liquid, or wort, passes through the bottom of the mash-tuns to the "under-back tank" on the ground floor, whence it is again elevated by steam-worked pumps through the copper and iron pipes to the copper boilers on the top story, to be boiled with a certain proportion of hops. An ingenious contrivance secures equality of temperature in this process. At intervals along the pipes which convey the wort to the upper story "steam jackets" are placed, through which jets of steam are introduced at the will of the person in charge between the outer or wooden partition of the tank and the inner or copper lining within which the liquid is conveyed; the effect being to preserve an equality of temperature which conduces greatly to the subsequent clearness and purity of the beer, and prevents it assuming a bluish or muddy colour that would detract from its quality, as it frequently does in other breweries.

The wort has now reached the third floor, where we follow it, and find two large boilers or "copper-heads," in which the liquid, now mixed with hops, is boiled for a time varying with the quality of the beer to be produced. These two boilers are capable of working at a given time nearly 140 barrels of beer. By the side of this is another boiler of huge dimensions, containing 230 barrels of hot water for the general purposes of the establishment. From the windows of the floor we perceive four large iron cisterns, the capacities of which are estimated at about 1,000 barrels, independent altogether of the supply of the wells to which we have already referred. But even this supply is carefully husbanded, for after the water in one of these reservoirs has been drawn upon to cool the wort, it is repumped to the upper part of the brewery and again used for the general purposes of cleaning.

Descending a few steps to the left we reach the hop-store, a spacious chamber, well aired, well lighted, scrupulously clean, and the walls lined with wood. This store contains a large stock of hops, principally from the gardens of Kent and Surrey.

Passing again through the copper-heads room, we arrive at the "hop-drainer." By an opening made in the bottom of the boilers above, the wort and hops, now well boiled together, flow into the "drainer," so that the liquor may be separated from the refuse of the hops that have been engaged in the manufacture of the beer. The drainer, which is some thirty feet in length, will contain about eighty barrels, and is fitted with a bottom of sectional perforated plates, through which the liquor gradually percolates, leaving the hop refuse behind. A series of copper pipes carry the liquor from under the bottom of the drainer to the coolers. In these the wort runs slowly along the surface of one half the floor, four large fans, driven by steam-power, and rotating with extreme velocity, imparting their cooling influence to the liquor as it courses to the end and returns along the other side of this long chamber, finding its way into the refrigerators. This delicate operation of cooling is carried out with a plentiful supply of cold water from the cisterns above the refrigerators, being the newest improvements introduced and patented by Mr. Morton of Stockton-on-Tees.

We next proceed to the works devoted to the important process of fermentation. In a spacious chamber, in which are fifty-six tuns capable of containing thirty-six imperial-gallon barrels of beer, the work of fermentation goes on. There is a fall of only two or three feet from the refrigerating to the fermenting department. As the wort enters it receives the necessary portion of yeast, and is allowed to remain in fermentation for four, five, or six days, according to the description of beer under treatment.

The wort having after several days' fermentation become beer, it is run off from the vats to the "brightening squares" on the ground floor. These are huge square wooden vessels, where the beer "flattens" and brightens up to the extent desired—an operation which occupies generally two or three days. At length the beer is conveyed by elastic tubes from the squares to the "stock-room vats," or, as is usually the case, put with some dry hops into barrels and sent to the export stores for bottling to meet demands in the home and foreign markets.

The bottling of the beers, though not strictly a department of their manufacture, deserves a line of notice. The bottles, as they are taken from the straw in which they have been packed, are removed to a water tank, and, having been cleaned outwardly, are placed, neck downwards, on a series of tubular spikes on a revolving circular frame. Through an aperture in the tube a strong jet of water is ejected upwards into the neck of the bottle, so that it is thoroughly cleansed from dust, straw, or other impurities. The ale or beer now arrives from the bulk store, flowing through flexible tubes to the bottling machines, which perform their work with extraordinary rapidity. One lad, in ten hours, can fill 120 dozens of bottles, and from 50,000 to 60,000 a week can be accomplished. The corking of the bottles is an interesting and expeditious operation. One boy places the bottle in the socket of the machine, another inserts a cork, which has been previously heated and moistened by a steam kettle, in the neck of the bottle, when the lever-working handle of the machine comes down and forces the cork home. A bottle breaks occasionally, but accidents are very rare. The bottles thus filled and corked are next handed over to more boys, whose business is to secure the corks with copper wire. The capsules bearing the name and trade-mark of the firm are next fastened over the cork and bottle-neck by a machine patented by the manufacturers of the capsules, Messrs. Betts and Co. of London. More boys now take possession of the bottles, and attach to them the distinctive labels; after which the bottles have twenty-four hours' rest for the labels to dry, and for the discovery of any leakage from faulty bottles.

The malting consists simply in drying barley which has previously been allowed to germinate to a certain degree. The drying is effected at a more or less elevated temperature in kilns of peculiar construction. By the germination of the grain the starch is converted to a considerable extent into sugar; and it is by the decomposition of the solution of this sugar, in the presence of the yeast, into alcohol and carbonic acid, as well as by the addition of the malt, that the beer is formed.

The difference in the composition of the barley before and after malting is shown in the following analytical figures:—

One hundred parts of barley contain:—

Starch	53·8
Dextrine	4·5
Albumen	9·7
Fat	2·1
Cellular tissue	7·7
Inorganic matter	2·5
Water	18·1
Extractive matter	1·6
	100·0

100 parts of malt, dried malt (I.), and strongly dried malt (II.), contain:—

	I.	II.
Starch	51·2	43·9
Dextrine	5·8	9·4
Sugar	0·6	0·8
Albumen	9·1	9·7
Fat	2·1	2·4
Cellular tissue	9·4	10·6
Inorganic matter	2·4	2·6
Water	11·1	8·2
Extractive matter	1·6	—
Constituents charred in drying	6·7	12·8
	100·0	100·4

The alcoholic strength of various well-known sorts of beer is given in the following table:—

	Per cent. of alcohol.
London export ale	6 to 8
London ale	4 „ 5
London export porter	5 „ 6
London porter	3 „ 4
Brussels "Lambik"	4·5 „ 6
Brussels "Faro"	2·5 „ 4
Bière forte de Strasbourg	4 „ 4·5
Bière blanche de Paris	3·5 „ 4
Bavarian beer	3 „ 4·5
Berlin "Weiss Bier"	1·8 „ 2

It is evident from this that the strongest of these beers contains only from 6 to 8 per cent. of alcohol, an amount not exceeding that of the lightest French or German wines. If, in spite of this low percentage, the British beer-drinker experiences an intoxicating influence beyond that which can be ascribed to the alcohol present, and in excess of that which would arise from the consumption of an equal amount of alcohol in the form of hock or claret, he must look to those unwholesome substitutes for the hop, so largely used, for the cause of it.

The results of a large number of careful determinations, made by various observers, of the amounts of alcohol, malt extract, carbonic acid, and water present in beers of every kind, and from different countries, are thrown together in the following table:—

	Malt extract.	Alcohol.	Carbonic acid.	Water.
London porter (Barclay and Perkins)	6·0	5·4	0·16	88·4
London porter	6·8	6·9	—	86·3
London porter (purchased in Berlin)	5·9	4·7	0·37	89·0
Burton ale	14·5	5·9	—	79·6
Scotch ale, Edinburgh	10·9	8·5	0·15	80·4
Berlin ale	6·3	7·6	0·17	85·9
Brussels "Lambik"	3·4	5·5	0·2	90·9
Brussels Faro	2·9	4·9	0·2	92·0
"Salvator" beer, Munich	9·4	4·6	0·18	85·8
"Bock Bier," Munich	9·2	4·2	0·17	86·5
Bavarian "Schenkbier," Munich	5·8	3·8	0·14	90·3
" "Lagerbier," Munich (16 months old)	5·0	5·1	0·15	89·7
" "Lagerbier," Munich	3·9	4·3	0·16	91·6
" "Schenkbier," Brunswick	5·4	3·5	—	91·1
" beer (Waldschlösschen)	4·8	3·6	—	91·5
"Schenkbier," Prague	6·7	2·4	—	90·7
"Stadtbier," Prague	10·9	3·9	—	85·2
Bavarian "Süssbier"	14·0	1·4	—	84·7
Josty's Bier, Berlin	2·6	2·6	0·5	94·3
Werder's "Braunbier," Berlin	3·1	2·3	0·3	94·2
"Weissbier," Berlin	5·7	1·9	0·6	91·8
Bière blanche de Louvain	3·0	4·0	—	93·0
Petermann's beer, Louvain	4·0	6·5	—	89·5
Mumme, Brunswick	45·0	1·9	—	53·1

Among the exhibitors of beer, in addition to the firms already mentioned, we notice Messrs. Allsopp and Sons, of Burton-on-Trent, although these gentlemen, in a letter to us, disclaim having exhibited anything this year. J. B. Charlier, of Ghent, shows bitter beer; J. A. Devenish and Co., of Weymouth, pale ales, in cask and bottle; Foll and Abbott, of Stoke's Croft Brewery, Bristol, strong beer, one or two years old. Joseph Holmes, of Leeds, has on exhibition ale-finings and samples of ales fined with these materials, as well as specimens of unfined ales. Mertens and Co., of Margate, direct our attention to solid wort-made malt and hops; and the Ostra Bryggeri Aktie Bolaget, of Halmsted, shows samples of all. John Plunkett and Co., of Dublin, exhibit their patent roasted malt, which they introduced in 1819; and Mrs. Plunkett, of the same city, patent brown and black malt. M. A. and F. J. Sedgwick, of Watford, show strong ales, as well as India and light pale ales. The time-honoured firm of Whitbread and Co. show bottled beer, and A. B. Wallis, of Dybeck Ystad, exhibits Dybeck Bavarian ale.

We are not a little astonished to miss the names of such firms as Bass and Guinness. Bavarian and Viennese brewers cannot be expected to make a good display this year at South Kensington, now that a great show is being held so much nearer home.

We pass now to the other great class of alcoholic drinks—wine, which, though not British as far as production is concerned, is yet, considering its vastly increasing consumption, not less important than beer. And here we shall make a slight digression in order to direct attention to the very unsatisfactory way in which many of the articles of food are displayed. Beyond the customary trade labels, no notes explanatory of their composition or mode of manufacture accompany them. It is, no doubt, easy enough for a newspaper reporter to obtain requisite information by communication with the exhibitors themselves, as we have done, but we question whether any of the public desirous of such particulars would be equally successful. With regard to no article have we found a greater dearth of details than in the case of wine. What avails an almost endless rank and file of bottles, so dark and black in many instances that it would require the electric beam of Tyndall to display even the colour of the wine within, if no analytical details, beyond those of Mr. Bell and Dr. Frankland on the composition of the more common sorts of wine, are given to characterize their contents. What shall be said of trays of earth and pebbles merely bearing the statement that they are specimens of soil from French and Spanish vineyards?

We are, for this reason, unable to make our report on the wines of the Exhibition so complete as we should desire. This matters, perhaps, little as far as the wines of Spain, France, and Germany are concerned, since they have over and over again formed the subject of elaborate treatises and memoirs. But the case is different with two varieties of wine—those of Australia and of Hungary, which have recently come into use in England.

We have already quoted Liebig's opinion on the value of alcoholic drinks in general, we will now state what he says of wine specially.

"Wine—as a restorative, as a means of refreshing when the powers of life are exhausted, as a means of correction and compensation where misproportion occurs in nutrition, and the organism is deranged in its operation, and as a means of protection against transient organic disturbances,—*wine is surpassed by no product of nature or art.*

"In virtue of its characteristic ingredients, wine unites in its composition a number of conditions, by which, in the human body, the consequences on the nervous system of the action of alcohol (which exalts the functions of the brain and spinal cord) are after a certain time more or less completely neutralized. Bad effects, therefore, must less frequently follow the use of wine than of alcohol.

"The quantity of wine consumed on the Rhine, by persons of all ages, without perceptible injury to their mental and bodily health, is hardly credible. Gout and calculous diseases are nowhere more rare than in the district of the Rheingau, so highly favoured by nature. In no part of Germany do the apothecaries' establishments bring so low a price as in the rich cities on the Rhine; for there wine is the universal medicine for the healthy as well as the sick; it is considered as milk for the aged."

What distinguishes wine from all other fermented liquids is that it contains an ether of a volatile acid,—the œnanthic ether—which imparts to wine the characteristic taste and smell.

We notice among the rich varieties of wines conspicuously displayed in the East Quadrant, the Hungarian specimens exhibited by Mr. Graeger. It is but a little more than ten years ago that the first attempt on a large scale was made to bring these wines under the notice of the English public, and we may therefore mention in a few words the origin of the present wine trade with Hungary.

In 1861, Mr. Max Graeger was encouraged by the Chamber of Commerce of Vienna to attempt the introduction of Hungarian wines into Great Britain. The time was considered favourable, as the duty on light wines imported into England had just been reduced to 1*s.* per gallon. Accordingly, he shipped a large quantity to London, and invited "the trade" to inspect the wines as they lay in St. Katherine's Docks. The "trade" would not even look at the wines. They were "novelties," and the British public, he was told, would neither learn new names nor acquire new tastes. Still farther, to his great surprise, disappointment, and heavy pecuniary loss, he found that his wines could not be admitted at the 1*s.* duty, because their alcoholic strength was considerably above 20 per cent.—this being the supposed limit of pure wines—instead of 18 per cent. and under, like the most of the French and German wines. He had, therefore, no chance whatever of selling to wholesale buyers, and he otherwise met with great discouragements. But as he could not understand why wines of unquestionable purity and of the most generous quality should be less accessible to the public because they were stronger in natural or *vinous* alcohol, and consequently fuller in body and in every respect better suited to the English climate than the great bulk of natural wines in common use, he persevered in his mission. Among other efforts he succeeded in placing before the proper Government authorities a clear and earnest representation. The Government, as it proved, was sincerely desirous that pure natural wines should be allowed fair admission into the country, and with courtesy and prompt energy the subject was inquired into, with the result that, in April, 1862, a new scale was sanctioned, allowing all wines under 26 per cent. of proof alcohol to be admitted at the 1*s.* duty. Meanwhile, the public had also learned that there did exist wines which were not and did not require to be *fortified* (*i. e.* protected from rapid decay) with raw spirits. In this matter the public found its chief instructor in the medical profession, which, with a rare unanimity, concurred in cordially recommending for general as well as special use the acknowledged pure wines of Hungary. Henceforth the successful introduction of Hungarian wines to the English consumer was recognized as a great fact; and, although introduced by a stranger, having no trade connections in this country, and unacquainted even with the language, the wines passing through his hands have reached the public under disadvantages that cannot well be conceived to have been greater; yet, relying exclusively upon the intrinsic excellence of their quality, they have reached a very high degree of public favour.

The above lines are Mr. Graeger's own statement; but what he says of the excellence of the wines of Hungary is fully supported by a Report of an Inquiry made under the authority of the British Government in 1861.

"It appears to be certain that the Hungarian wine growers do not adulterate their wines; indeed they are so generally good, that they would certainly be deteriorated if alcohol were added. . . . . While possessing a great resemblance to the wines of Burgundy and the Rhine, the better wines of Hungary have greater body and strength, and would be more likely to suit the English taste. . . . There is probably no country in which so great a proportion of good wine is made."

Not less pronounced is the praise given by the subjoined lines, taken from "Reports by her Majesty's Secretaries of Embassy and Legation on the effects of the wine disease on the Commerce, &c., of the countries in which they reside":—

"Hungary holds in importance the second rank amongst the

wine-growing countries in Europe. There are some economists who are of opinion that if this branch of agricultural industry were more actively and intelligently promoted in Hungary, it might become the first wine-producing country in Europe. . . . I have already stated that the Hungarian wines are best adapted for exportation, and that there the disease never made its appearance. At a time when the wines of other countries were decimated by the disease, they were in Hungary in a healthy condition. They were called upon to supply in the European market the great deficiency caused by the disease of French and other wines; and it is to this circumstance that they owe the estimation in which they are now held in countries where they had never been heard of before, and the consequent increased and increasing demand made for them abroad. . . . These wines are, as a rule, drier than the French wines; more mellow than those of the Rhine, and more fragrant than the choicest of Spain. . . . . When the improvements which are now being made in the manipulation of Hungarian wines have taken full effect, and when the means of transport in the country shall have been extended and improved, the table wines of Hungary, from their intrinsic merits, will be likely to carry on a successful competition against their French rivals in the English market."

Liebig, than whom no greater authority on matters of food and drink we could quote, says of the Hungarian wines that they have over other wines a *particular restorative virtue*, to be attributed to the phosphoric acid they contain.

The following table shows some of the constituents, &c., of those varieties which have become more or less familiar to the English consumer.

Hungarian Wines.	Specific Gravity.	Alcohol, per cent.		Acids equal to Tartaric Acid, grs. per 1,000	Extract grs. per 1,000	Ash, grs. per 1,000.
		By volume.	Equal to Proof Spirit.			
Red Wines—						
Erlau	992·8	11·40	20·00	6·29	19·70	1·90
Carlowitz (1)	993·9	12·00	21·06	5·00	21·50	2·10
Do. (2)	994·9	13·80	24·21	6·72	30·60	1·80
Do. (3)	992·8	13·50	23·69	6·72	26·60	2·00
Do. (4)	992·9	13·80	24·21	6·58	27·50	2·25
Ofner Auslese	995·2	12·45	21·84	5·72	29·50	2·30
Do. do.	995·0	11·75	20·62	6·72	25·20	1·80
Do. Adelsberg	994·3	11·40	20·00	7·43	23·10	1·80
Segszarder, Auslese	994·9	11·55	20·26	6·72	26·14	2·10
Visonta	993·1	11·90	20·80	7·58	20·10	1·80
White Wines—						
Neszmely	992·7	11·20	19·65	5·86	21·40	1·90
Dioszeg Bakator	993·4	10·10	17·72	5·14	16·24	2·00
Somlau	992·8	11·40	20·00	7·15	20·54	2·20
Edenburg	992·2	10·60	18·60	5·14	18·10	1·90
Ofner Auslese	992·7	12·00	21·06	5·71	21·40	1·90
Szamorodny	992·4	13·05	22·90	7·15	27·22	1·90
Ruster Ausbruch, dry	993·3	12·25	21·49	6·43	25·50	1·80
Mediasch	992·6	12·18	21·37	6·86	16·20	1·70
Maximum	995·2	13·80	24·21	7·58	30·60	2·30
Minimum	992·2	10·10	17·22	5·00	16·20	1·70
Average	993·3	12·01	21·08	6·32	23·14	1·95

For comparison's sake the analysis of some of the more current wines in the English market may follow here.

Miscellaneous Wines.	Specific Gravity.	Alcohol, per cent.		Acids equal to Tartaric Acid, grs. per 1000	Extract, grs. per 1000.	Ash, grs. per 1000.
		By volume.	Equal to Proof Spirit.			
Natural Wines—French.						
Claret, good average quality	995·8	10·10	17·72	6·86	21·91	1·70
Red Hermitage, direct from vineyard, common quality, very good	994·7	10·70	18·77	7·15	22·00	2·25
Red Burgundy—1847—fine quality	994·9	9·50	16·67	6·51	21·80	3·00
German—						
Steinberg—Rhine—choice quality	994·7	10·60	18·60	6·58	24·00	2·10
Pisporter—Moselle—good quality	995·3	10·10	17·72	7·58	23·80	1·70
Australian—						
Red, slightly fortified	990·4	14·50	25·44	5·55	22·20	2·90
White, do.	991·3	15·00	26·32	5·90	24·33	3·00
Spurious Wines— (Highly fortified, and loaded with extraneous matter.)						
Spanish—						
Sherry, a very passable cheap Sherry, direct from grower	991·2	20·40	35·80	4·39	41·05	3·95
Do., a first-class quality	992·2	21·00	36·85	4·21	38·60	4·90
Malaga, pale sweet mountain	1025·2	19·40	34·04	5·90	113·40	3·60
Tarragona (Red), a blend of dry and sweet wine, largely sold as Port in the U.K.	1008·6	20·70	36·32	4·29	86·90	4·00
Alicante (Red), imitation dry Port	1021·6	17·20	30·18	5·14	90·70	6·50
Portuguese—						
Port, old, average quality	994·0	17·10	30·01	4·07	35·00	2·00
Do. best quality imported	996·1	20·50	35·97	4·72	46·30	2·30
Sicilian—						
Marsala—White	995·2	17·10	30·01	5·47	36·24	4·25
Do. old (Red), largely used in Ireland	995·0	19·60	34·39	5·29	46·74	4·74

In order to make the meaning of these tables clear to the general reader, we will quote the explanatory remarks given by the chemical investigator who supplied these analytical figures.

The quality of wine termed "acidity" is a very important point, and one regarding which not a little misconception prevails. All wines contain acids, and they therefore manifest more or less potently the character of acidity. It is an essential and invariable quality of wine, and the presence of the proper acids contributes materially to the flavour, pleasantness, and medicinal virtues of wine as a beverage. The acids in wine are present partly in a free state, and partly in chemical combination as neutral or acid salts. It is sometimes alleged that all free acid in wine is objectionable, but this is a mistake. The quality of acidity is essentially associated with the characteristic aromas arising from the development of ethers, and in a marked degree with the soundness and durability of wines, the latter property being remarkably exemplified in Rhine wines. The extensive analyses of Rhine wines conducted by Schubert, and also by Kersting, show that the free acids in these wines range from 6 to 12½ grains in 1,000 grains of wine, and that the average proportion is from 6 to 9 grains. In considering the acids of wines, however, it is necessary to distinguish those which are normal, and which naturally exist in the juice of the grape, and those which are formed by an after-souring or spoiling of the wine. In a word, we have the proper and wholesome acids, which are pre-eminently essential constituents of genuine wine, and we have the improper, souring, and hurtful acids of inferior and spoiled wine. The latter, which are of uncertain quantity, are generated by the chemical changes of the alcohol and other constituents, owing to the inferiority of the grape, poverty of the wine, deficiency of alcohol, defective fermentation, or manufacture, or, in some cases, to actual adulteration. These acids are not present in the original grape juice, but are products of after chemical alterations which it undergoes; and their existence in appreciable quantity in wine is an indication that the wine is in the incipient stage of conversion into vinegar.

The chemical terms "extract" and "ash," which are used in the tables of analysis, are worthy of special consideration. When a known quantity of any wine is evaporated to complete dryness, the residue is termed the "extract," and it consists of all the *solid* ingredients of the wine—that is, of sugar, gum, albumen, non-volatile acids, and salts of organic and inorganic acids—in short, of everything except the water, alcohol, ether, and other volatile matters. The extract is obviously a chemical result of considerable practical value. In pure wines of the same class its amount is restricted within a narrow limit, and rarely exceeds a certain maximum. Spurious wines, on the contrary, are loaded with impurities, and the amount of extract in them is very variable, but always considerable.

Still more important, however, because less capable of undergoing change in its primitive composition, is the "ash" of wine. When the dried "extract" of wine is burned a certain quantity of incombustible matter remains, and this is termed "ash." It consists principally of inorganic saline substances. It varies very little in amount in pure wines, especially of the same class and species, and hence the quantity of ash may be looked upon as one of the distinctive marks of genuine wine, and a test, therefore, of the greatest value.

In Bordeaux and Rhine wines, the quantity of ash is nearly the same in both, and ranges from 2½ to 1½ parts in 1000, the average being 1·9—a quantity that is found usually in the best specimens. Now, it is very interesting to observe that this average corresponds almost exactly with that of Hungarian wines; but the comparison is so far in favour of the latter, that there is not in them so wide a range as in the Bordeaux and Rhine wines, and therefore not so glaring an inequality in one of the most essential characters of good wine.

With regard to the names of the Hungarian wines, there is no doubt some difficulty experienced in learning and properly pronouncing their distinctive titles. This, however, is a difficulty common to all novelties of the kind, and especially to those that are foreign. Some persons perhaps would be inclined to recommend that they should be called "Hungarian Clarets," "Hungarian Hocks," &c. &c.; but such a system of nomenclature, apart altogether from the injustice it would do to the country in which the wines are produced, would extinguish the identity of these wines, and lead to most fallacious views of their true nature and qualities, and confuse them with wines from which they stand wholly apart. They form a class of wines *sui generis*, and should be so preserved. The temporary inconvenience unavoidably attached to new and admittedly difficult names will be easily surmounted by those who have little or no experience in Hungarian wines, by not attempting to become familiar with all the members of the class, but to limit the attention to one or two leading varieties.

We should have liked to give about the Australian wines as detailed a notice as about the above-described variety, but want of satisfactory information, as well as considerations of space, prevent us from doing so.

Exhibitors of fine French wines are M. Bissey, Volnay-near-Beaune; M. Vanura, Bordeaux; and Roederer, the well known champagne firm of Rheims. Choice specimens of Rhenish wines, viz., Liebfrauenmilch, Klostergarten, Marcobrunn, and Steinberg Cabinet are shown by P. J. Valckenberg, Worms-on-the-Rhine. J. L. Denman, London, has a large assortment of unbrandied Greek wines; J. Ferrandi, Paris; and J. P. Paoli, Morsiglia, in Corsica, have sent samples of the wines of Corsica; G. Scala, Naples, puts before us Lacrima Cristi and the classical Falerno; E. Labarrère, Lambese in Algeria, exhibits red and white wines of his country. We will close our list with J. Marshall and Sons, Edinburgh, and the Rev. R. Fenn, Woodstock, who illustrate British viniculture by wines made of gooseberry and rhubarb. In this division, too, we miss some well-known names in the wine trade.

The third division of the drinks comprehends the spirits and liqueurs.

Under "spirit," we understand a mixture of alcohol and water, varying in strength from about 40 parts to 70 parts of the first in 100 parts of the mixture, which mixture contains, besides, some volatile oil, differing according to the source the spirit has been obtained from. If this volatile substance is of a pleasant odour, it is honoured with the designation "aroma;" if it is repulsive to the odoriferous sense, it is named "fusel." The principal raw materials from which spirit is derived are wine, the different varieties of grain, potatoes, sugar-cane, and beet-root. Spirit from wine is "Cognac" proper, though this name has been boldly appropriated to grain spirits; these latter ought, when yet in the unmixed state in which they are got in the distillation, to be termed "brandies;" the sugar-cane (and perhaps also the beet-root) yield what is known as "rum."

The basis of all the varieties (with very few exceptions) of spirits, as gin, whiskey, Hollands, &c., and of liqueurs whose names are legion, is brandy. Brandy, as we said, is got from potatoes, or some grain. The raw material is mashed or ground up, mixed with water, and left to ferment. The fermented liquid is submitted to distillation, and the distillate purified by filtration through charcoal. If the last operation is carefully and conscientiously done, almost all the fusel oil can be eliminated.

The collection of liqueurs is a very rich one. As we pass along from case to case, strange-shaped bottles, with still stranger labels, present themselves to our view. There are bitters, not less than ten kinds of punch, mostly from Sweden, Chartreuse, white, yellow, and green absinthes, vermouth, elixirs, cordials, the delicious maraschino, curaçoa, kirschwasser, kümmel, &c. All these liqueurs are spirit of wine, mixed with various vegetable extracts and some essential oil. T. B. C. Schoofs, of Brussels, exhibits a collection of such extracts for making liqueurs. We are somewhat astonished to miss the renowned—at least, so far as names are concerned—transatlantic inventions, "brandy-smash," "cock-tail," "eye-opener," "corpse-reviver," &c.

In the division of drinks, we must naturally give a passing mention to the sodas, Seltzers, aërated waters, ginger-beer, &c. Soda-water is water artificially impregnated with carbonic acid; Seltzer contains, in addition to this, some salts, in imitation of the natural Seltzer; aërated waters are supposed to be saturated with common atmospheric air.

L. Rose and Co. of Leith exhibit fine samples of lime-juice. They succeed in producing a juice capable of being preserved for a long time, without undergoing fermentation of any kind, in the first order by ensuring the preparation of the raw juice from sound limes only, and then by treating it after a peculiar process of their own. From the pure liquor thus obtained, a variety of pleasant and refreshing beverages are manufactured. Messrs. L. Rose and Co. inform us that the quantity of raw juice now imported (chiefly from the West Indies) by them alone is ten times that of the total brought ten years ago into this country. The use of lime-juice for curing and preventing scurvy is, of course, well known.

With food and drink proper we have done. But before leaving these sections we have a word about adulterations. We are quite stunned, when looking on the objects exhibited under No. 4,328, which illustrate the adulterations to which various articles of food are subject. Indeed, the catalogue enumerates *all* the substances exhibited in sections B and D of Class XII. as being met with in a more or less adulterated state. This little corner of the Exhibition makes a very disheartening impression, it almost obliterates the feeling of pleasure produced by the aspect of the rich and excellent things collected in the Food Department. Well, we have got now an Adulteration Act; let us hope it will prove impassable for "a coach and six."

Few articles are adulterated in such a gross manner as wine,—if adulterating is the right word when we learn that wines are made which never knew a grape. For the amusement of the reader we will reproduce here the description, by a popular writer, of Cette, a town in the south of France, renowned for concocting spurious wines on a very large scale:—

"Cette is a great manufacturing place, and that which they manufacture is neither cotton nor wool, Périgord pies, nor Rheims buscuits—but *wine*. '*Ici*,' will a Cette industrial write with the greatest coolness over his porte cochère—'*Ici on fabrique des vins*.' [Here they make wine.] All the wines in the world, indeed, are made in Cette. You have only to give an order for Johannisberg or Tokay—nay, for all I know, for the Falernian of the Romans, or the nectar of the gods—and the Cette manufacturers will promptly supply you. They are great chemists, those gentlemen, and have brought the noble art of adulteration to a perfection which would make our own mere logwood and sloe-juice practitioners pale and wan with envy. But the great trade of the place is not so much adulterating as concocting wine. Cette is well situated for this notable manufacture. The wines of Southern Spain are brought by coasters from Barcelona and Valencia; the inferior Bordeaux growths come pouring from the Garonne by the Canal du Midi; the hot and fiery Rhine wines are floated along the chain of *étangs* and canals from Beaucaire. With all these raw materials, and of course a chemical laboratory to boot, it would be hard if the clever folks of Cette could not turn out a very good imitation of any wine in demand. They will doctor you up bad Bordeaux with violet powder and rough cider, colour it with cochineal and tournesol, and outswear creation that it is precious Château Margaux, vintage of '25. Champagne, of course, they make by hogsheads. Do you wish sweet liqueur, wines from Italy and the Levant? The Cette people will mingle old Rhine wines with boiled sweet wines from the neighbourhood of Lunel, and charge you any price per bottle. Do you wish to make new claret old? A Cette manufacturer will place it in his oven, and after twenty-four hours' regulated application of heat, return it to you nine years in bottle. Port, sherry, and Madeira, of course, are fabricated in abundance with any sort of bad, cheap wine and brandy for a stock, and with half the concoction in a druggist's shop for seasoning. Cette, in fact, is the very capital and emporium of the tricks and rascalities of the wine trade, and it supplies almost all the Brazils and a great proportion of the Northern European nations with their after-dinner drinks. To the grateful Yankees it sends out thousands of tons of Ay and Moet, besides no end of Johannisberg, Hermitage, and Château Margaux, the fine qualities and dainty aroma of which are highly prized by the transatlantic amateurs. The Dutch flag flutters plentifully in the harbour, so that I presume Mynheer is a customer to the Cette industrials; or, at all events, he helps on the distribution of their wares. The French West Indian colonies also patronise their ingenious countrymen of Cette, and Russian magnates get drunk on Chambertin and Romanee Conti made of low Rhine, and low Burgundy beverages, eked out by the contents of the graduated phial. I fear, however, that we do come in--in the matter of 'fine golden sherries at 22*s.* 9½*d.* a dozen,' or 'peculiar old crusted port at 1*s.* 9*d.*'—for a share of the Cette manufactures; and it is very probable that, after the wine is fabricated upon the shores of the Mediterranean, it is still further *improved* upon the banks of the Thames."

The state of various samples of water, before and after filtration, is shown in a set of tubes (No. 4332), through which the ray of light passes longitudinally. The catalogue mentions a "tube containing pure or distilled water" as being, for comparison' sake, placed beside the other samples, but we could see nothing of it; may be, the exhibition of such a specimen was thought to be too hard on the metropolitan water companies.

(*To be continued.*)

NEW Process for Preserving Organic Matters.--LAUJORROIS proposes to add one per cent. of fuchsine to the substance to be preserved, whereby decomposition and putrescence is avoided: meat wrapped in paper impregnated with fuchsine kept unaltered for months; gelatine thus treated was perfectly preserved for eleven months; similarly urine, coffee, &c., can be easily preserved from decomposition and mouldiness. *Revue Hebdomadaire*, 1873, 256.

[*Note by Abstractor.*—Fuchsine very frequently contains considerable quantities of arsenical compounds; possibly the preservative action noticed by Laujorrois may be due to the presence of arsenic in the substances employed: in any case, the use of a material so likely to be poisonous, can hardly be recommended in the case of edible substances.—C. R. A. WRIGHT.]